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FOCUSED SOUTH DITCH REMEDIAL INVESTIGATION REPORT

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1.0 INTRODUCTION

An Interim Consent Order (ICO) was entered November 6, 1995, requiring Horsehead Industries, Inc., Mobil Oil Corporation, and Viacom International Inc. (collectively referred to as the DePue Group) to perform certain work at the DePue Site (Site). Section XI of the ICO and Item 5 of Attachment 1, Statement of Work (SOW), requires the DePue Group to conduct and complete a "Focused RI/FS" for the South Ditch. This document presents the revised Focused Remedial Investigation Report (Focused RI Report) for the South Ditch Study Area (Study Area). The Focused RI Report was initially submitted on August 26, 1996. Revisions to this document are based on comments provided by the Illinois Environmental Protection Agency on September 27, November 15, and November 18, 1996, and January 27, February 10, and April 24, 1997.

The Focused RI was conducted and this revised report was prepared in general accordance with the Focused South Ditch Remedial Investigation/Feasibility Study Work Plan (Work Plan), prepared by Golder Associates Inc. on behalf of the DePue Group. The Work Plan was approved by the Illinois Environmental Protection Agency (IEPA) during a meeting at the Site on February 26, 1996. The Focused RI report has also been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), the Illinois Contingency Plan (ICP), and United States Environmental Protection Agency (USEPA) guidance on remedial investigations.

1.1 Objectives

The primary objective of the Focused RI was to determine whether the unnatural sediment within the Study Area requires an expedited remedial action. The work scope was structured to characterize the horizontal and vertical extent of unnatural sediment within the Study Area. The Focused RI included a qualitative risk assessment to determine whether the unnatural sediment presents an acute human health or ecological risk. The potential chronic toxicity of the unnatural sediment was not addressed as part of the Focused RI, but will be considered as part of the Site-Wide RI/FS.

The Focused FS will present an analysis of remedial alternatives that could be implemented to mitigate the potential acute risk that may be associated with the unnatural sediment.

The following specific objectives were established for the Focused RI:

- review available aerial photographs and provide field confirmation concerning the extent of the unnatural sediment within the Study Area;
- define the floodplain/floodway boundaries and lowlands which may be impacted under various remedial alternatives;
- obtain the necessary physical data to evaluate feasible remedial alternatives;
- integrate the results from the South Ditch Corridor Hydrogeologic Study (Golder, December 1995) to evaluate the interactions between groundwater and the unnatural sediment;
- characterize the vertical and horizontal extent and quality of the unnatural sediment in the Study Area; and
- evaluate the acute human health and ecological risk, if any, posed by the unnatural sediment.

1.2 Site Background

1.2.1 Location and Property Description

The Site is located in the Village of DePue, Bureau County, Illinois, as shown on Figure 1-1. The Site is divided into three areas, which include: the Phosphogypsum Stack Area to the north, where phosphogypsum produced from the manufacture of phosphate fertilizer was placed; the Former Plant Site Area, where zinc and phosphate ore processing facilities were situated, and; the Southeast Area, which includes a Former Municipal Dump, a portion of Lake DePue, and the subject of this study, the South Ditch.

1.2.2 Site History

A portion of the Site operated as a zinc smelting facility from 1904 through the early 1970s, and as a zinc dust manufacturing facility in the 1980s. From 1923 until approximately 1955 a lithopone pigment manufacturing plant was operated on a portion of the Former Plant Site Area. From 1967 until 1987, a portion of the Site was used as a diammonium phosphate fertilizer manufacturing plant. Zinc Corporation of America (ZCA), an unincorporated division of Horsehead Industries, Inc., currently owns approximately 110 acres of the Site and Mobil owns approximately 750 acres of the Site. Portions of the Site were previously owned by predecessors of Viacom International Inc. (Viacom). For a more complete Site history, refer to the Site Assessment Plan (SAP) prepared by Terra Environmental Services, Inc. (Terra), on behalf of the DePue Group, (originally submitted in December 1995 and revised in August 1996).

In 1989 through 1991, The New Jersey Zinc Company (NJZ), now ZCA, implemented a plan to improve the water quality within the South Ditch. The plan was implemented as part of a compliance plan included in an Opinion and Order of the Board from the Illinois Pollution Control Board (PCB-88-130) dated January 19, 1989. Various elements of the compliance plan were initiated in 1989 and completed in 1991.

In accordance with the compliance plan, the ditch south of the Primary Zinc Slag Pile was lined with Iron Rich Material (IRM) and six-inch crushed stone, and an in-situ, passive groundwater treatment system was installed between the slag pile and railroad right-of-way. The in-situ passive groundwater treatment system consisted of three IRM walls (North, Center, and South) which were constructed by excavating trenches to a depth below the water table and backfilling with IRM. A 10-inch diameter perforated underdrain was then installed along the length of the Center and South IRM walls. The Center and South IRM wall underdrains were connected to one of two, sealed 12-inch diameter reinforced concrete pipes to route collected water to the existing sump south of Marquette Street.

1.3 Physical Characteristics of the South Ditch Study Area

The following sections describe the physical characteristics of the Study Area, which is shown on Figure 1-2.

1.3.1 Physiography and Drainage

The South Ditch Study Area consists of a drainage channel which begins south of Marquette Street and ends at Lake DePue. The northernmost 150-feet of the South Ditch is flanked by a low-level terrace. The remainder of the South Ditch Study Area is located within a marshy lowland adjacent to Lake DePue. Land surface elevations adjacent to the South Ditch channel range from between approximately 441 feet above mean sea level (msl) to 450 feet above msl. The unnatural sediment extends downstream from the South Ditch outfall to the discharge into Lake DePue, within the channel of the South Ditch.

Figure 1-3 shows the system of open-channel and piped drains which contribute surface and groundwater flow to the South Ditch. The North Ditch serves as a local discharge zone for groundwater and conveys surface water from the eastern portion of the Former Plant Site Area and the bluffs to the north of the South Ditch. Figure 1-3 shows that flow from the North Ditch enters the National Pollution Discharge Elimination System (NPDES) drain and passes through a High Density Polyethylene-lined, buried 24-inch concrete reinforced pipe to the existing sump, where it is joined by flows from the Center and South IRM walls. A drainage ditch that collects runoff from the Primary Zinc Slag Pile cap area discharges to a manhole that receives the drainage from the North Ditch. This discharge from the Primary Zinc Slag Pile has been observed to be a minor component of the flow to the NPDES discharge. From the existing sump, flow is directed under the railroad right-of-way to the outlet in the South Ditch via a 36-inch pipe. Consequently, flow to the South Ditch is derived from the catchment area of the North Ditch, groundwater discharges from the Center and South IRM underdrains, and runoff from a portion of the Primary Zinc Slag Pile. These flows are supplemented by numerous springs which have been observed near the head of the South Ditch. Figure

1-3 shows the locations of the springs near the head of the South Ditch. As Figure 1-3 shows, there are two springs located along the east bank of the South Ditch, north of the west branch that have been identified. These springs have been observed to flow at total estimated rate of approximately 10 gallons per minute. A subaqueous spring has been identified in the west branch. The activity of the spring is evidenced by air bubbles and a clearing within the otherwise algae covered water. These conditions have been observed throughout the year, indicating that the spring is consistently active.

The DePue Group is proceeding with the construction of an interim water treatment plant (IWTP), which will treat flows to the existing sump and significantly reduce the metals loading to the South Ditch. These flows include NJZ's permitted Outfall 001 (IEPA NPDES Permit No. IL0052183, existing sump west pipe), and the discharges from the Center and South IRM walls (existing sump center and east pipes, respectively). In addition, the IWTP will treat water received from shallow interceptor drains that have been designed to collect shallow groundwater to prevent this groundwater from discharging into road side ditches along Marquette Street. These shallow drains have been placed to depths ranging between 1 and 3 feet and are located about 4 feet off both the north and south sides of Marquette Street. The drain on the north side of Marquette Street is centered at the lift station and is approximately 370 feet in length. The drain on the south side of Marquette Street is also centered at the lift station and is approximately 306 feet in length. The drains contain perforated pipe and are backfilled with a filter medium. These drains will intercept shallow groundwater that otherwise would discharge to the South Ditch. Water collected by these interceptor drains will be directed to the IWTP, and with the current design, subsequently returned to the South Ditch.

1.3.2 Geology

In descending order, the near-surface manmade and natural materials at the Site consist of the following: fill, organic soil (Wisconsinan and Holocene age Grayslake Peat), outwash and alluvial sands (Wisconsinan age Henry Formation and possibly the pre-Illinois age Sankoty Formation), and shale bedrock (Pennsylvanian-age Modesto Formation) (Terra, 1995).

Based on information collected during the transect investigation of the Focused RI, no fill, other than the unnatural sediment, is present within the confines of the South Ditch Study Area. However, the low level terrace surfaces surrounding the northern edge of the South Ditch are generally comprised of between 5 and 15 feet of fill. In addition, fill including municipal waste, demolition debris, and zinc smelter slag is located immediately east of the northern edge of the South Ditch.

The organic soil (Grayslake Peat) consists of organic silt, organic clay, and peat. The Grayslake Peat (hereinafter referred to as the Peat) forms a southward thickening wedge under the fill within the eastern portion of the Former Plant Site Area and the northern portion of the Southeast Area. In the northern portions of the Southeast Area where fill is absent, the Peat extends to the ground surface. The extent of the Peat within the southern portion of the Study Area has not been determined. At the northern edge of the South Ditch, the Peat is approximately 10 feet thick.

Sands with varying quantities of silt and gravel underlie the Peat and/or fill at the Site and extend to the bedrock surface. The sands were deposited as alluvium and outwash within the Illinois River drainageway. Based on only two boreholes (DSB-1 and DSB-2) that have penetrated the entire alluvium/outwash at the Site, the data suggest that no correlatable units within the sands can be identified and that the materials generally coarsen with depth. However, a 5-foot thick clayey horizon was identified at about elevation 430 feet msl within the alluvium/outwash at DSB-2, located in the north-central part of the Former Plant Site Area.

Terra encountered bedrock at elevations of 413 and 406 feet msl in boreholes DSB-1 and DSB-2, respectively. Regional information suggests bedrock at the Site consists of the Pennsylvanian age Modesto Formation.

1.3.3 Hydrogeology

The hydrogeology of the South Ditch area was investigated during late 1995 by Golder (South Ditch Corridor Hydrogeologic Study, December, 1995). During this investigation,

monitoring wells were installed, water levels were measured, in-situ hydraulic conductivity testing was performed, and groundwater samples were collected and analyzed for inorganic parameters. Figure 1-4 shows the location of piezometers/wells on the Site. The results of the study were submitted to the agencies as an appendix to Terra's SAP. During this Focused RI, additional information on the distribution of heads in the South Ditch area was obtained through installation of three piezometers into the channel bottom material beneath the unnatural sediment. The following discussion of the hydrogeology of the South Ditch is based largely on the results of the South Ditch Corridor Hydrogeologic Study.

The groundwater units at the Site include the shallow water bearing zone and the alluvial aquifer.

The shallow water bearing zone at the Site acts as an unconfined system. The shallow water bearing zone occurs over the eastern part of the Site where the alluvial aquifer is overlain by the lower permeability Peat. The flow system within the shallow water bearing zone is limited to the saturated zone within the natural soils, residue, and fill material located above the Peat. The shallow water bearing zone is recharged by precipitation, runoff from the upland bluffs located to the north of the Former Plant Site Area, and locally by discharge from the alluvial system. The Peat layer underlying the shallow water bearing zone functions as an aquitard between the two groundwater units. Figure 1-5 shows a subsurface cross-section from the Former Plant Site Area to the Study Area. Discharge from the shallow water bearing zone to the South Ditch in the form of springs and seeps has been observed near the head of the South Ditch. The flow system within the shallow water bearing zone appears to be influenced by anthropogenic features (i.e., the IRM wall underdrains).

The distribution of the shallow water-bearing units in the South Ditch Study Area is shown on Figure 1-6. The shallow groundwater system in the northern portion of the Study Area occurs in fill and native materials. The southern portion of the shallow groundwater system consists of a thin veneer of recent deposits overlying the Peat which is at or near the surface. It is assumed that the hydraulic properties of the shallow

system in the southern portion of the Study Area will be more like the Peat than the fill materials in the northern portion of the Study Area. Specifically, the hydraulic conductivity of the shallow zone in the southern portion is most likely much less than in the northern portion.

The alluvial aquifer occurs within alluvial and outwash materials deposited within the Illinois River drainageway. Within the vicinity of the Former Plant Site Area, the alluvial aquifer is recharged by outwash sands underlying the bluff which are truncated by alluvial sediment, and by precipitation in areas where the Peat is absent. The alluvial aquifer may discharge to Lake DePue and/or the Illinois River.

The horizontal hydraulic gradients for both the shallow water-bearing zone and the alluvial aquifer are characterized by southward flow. Figures 1-7 and 1-8 show potentiometric surfaces for two rounds of water levels. South of the Primary Zinc Slag Pile, groundwater flow appears to converge on the South Ditch.

Vertical hydraulic gradients exist locally between the shallow water bearing zone and the alluvial aquifer. During the South Ditch Corridor Hydrogeologic Study, a slight downward gradient across the Peat of 0.03 was observed between monitoring wells HS6(S) and HS7(I). Upward gradients across the Peat were observed at monitoring well nests PS-8/HS2(I) (0.02) and HS12(S)/HS13(I) (0.008). No vertical hydraulic gradient was observed at the HS1(S)/PS-7 well nest. These vertical hydraulic gradients suggest upward gradients along the Study Area. Both the shallow water bearing zone and the alluvial aquifer are characterized by southward horizontal hydraulic gradients. South of Marquette Street, groundwater elevation data and water level measurements in the South Ditch suggest that flow in the shallow water bearing zone converges on the South Ditch. The South Ditch beginning at the outfall, therefore, appears to be a discharge point for shallow groundwater from the eastern part of the Former Plant Site Area.

The South and Central IRM walls, both of which contain underdrains, appear to induce large head losses within the shallow water bearing zone. The head losses account for a greater than 50% reduction in the saturated thickness of the shallow water bearing zone

downgradient of the IRM underdrains. This suggests that the underdrains are intercepting more than half of the groundwater flow in the shallow water bearing zone. Historical flow data for the sump east pipe (which drains the South IRM wall), and the sump center pipe (which drains the Center IRM wall), indicate that the flows vary significantly over time. Most of this fluctuation in flows probably reflects variations in recharge due to precipitation patterns. The location of the sump and the approximate pipe configurations are shown on Figure 1-3. During dry periods, the cumulative IRM flow may be as low as five to ten gallons per minute; these low flows are likely to be representative of the groundwater flow component. Based on the observed decrease in saturated thickness of the shallow water bearing zone across the IRM walls, at least half of the southward groundwater flow in the shallow water bearing zone is captured by the IRM walls. Therefore, total southward groundwater flow in the shallow water bearing zone toward the IRM walls should be approximately 10 to 20 gallons per minute.

2.0 STUDY AREA INVESTIGATION

The Study Area investigation focused primarily on delineating the horizontal and vertical extent of unnatural sediment in the Study Area, and evaluating the metals loading to the unnatural sediment and the underlying channel bottom material. To accomplish these objectives, the investigation was organized to include the following tasks: unnatural sediment delineation; channel profile investigation; unnatural sediment and background sediment characterization; channel bottom sampling; and a temporary piezometer investigation. These tasks are described in the following sections.

2.1 South Ditch Unnatural Sediment Investigation

Field activities commenced on February 26, 1996, and were mostly completed by March 8, 1996. A few activities, including water level measurements in the temporary piezometers, and completion of channel profile measurements at selected transect locations, were completed in August 1996. The following sections describe the methods used during the field investigation.

On February 26, 1996, representatives from the DePue Group, IEPA, Ecology and Environment (E&E), and Golder met in the Study Area for the purpose of establishing the boundaries of the Study Area, including both its length and lateral extent. The South Ditch length, from the head at the 36-inch culvert outfall to the mouth at Lake DePue, was measured to be approximately 1,670 feet. Thirteen transect locations were established at approximately 130 foot intervals along the length of the South Ditch. A fourteenth transect location was placed in the east-west leg of the South Ditch. A series of fence posts, driven into the ground along both sides of the South Ditch, served both to identify the Study Area boundary and to establish the endpoints of each of the 14 transect lines. Each of the transect endpoints was subsequently surveyed by an Illinois licensed surveyor. Sampling and measurement activities were then referenced to the transect endpoints. Figure 2-1 shows the location of each of the 14 transects.

2.1.1 Unnatural Sediment Delineation

The purpose of this part of the investigation was to determine the horizontal and vertical extent of the unnatural sediment in the South Ditch. The determination of the horizontal extent was based on a two-phased approach. The first phase involved a desktop review of recent aerial photographs to establish the extent of unnatural sediment based on color differences and the actual South Ditch channel location. One of the recent aerial photographs was scanned and scaled to match the scale of a two-foot contour interval topographic map for the Site which is presented as Figure 2-2. Using fixed landmarks, the scanned aerial photograph and the topographic map were then superimposed, thus establishing a reasonably accurate basemap from which to begin the second phase, or field confirmation, of the unnatural sediment delineation as described above.

The field confirmation phase was based primarily on color differences. The unnatural sediment exhibited a pale green color as compared to the underlying channel bottom, which appeared to consist of brown to black colored native material. Based on this criterion, the lateral extent of the unnatural sediment in the northern portion of the South Ditch, coincided with the channel edges. It was more difficult, however, to establish the lateral extent of the unnatural sediment along the southern portion of the South Ditch where color changes were more gradational and where the channel was not as well defined. At these locations, the transect endpoints were placed where there was evidence of recent stream activity, such as small bank cuts, disturbed vegetation, or at the boundaries between vegetated and non-vegetated areas. The impoundments created by the six identified beaver dams contained unnatural sediment that had accumulated due to the damming of the South Ditch at these locations. The extent of the unnatural sediment within these impoundments was mapped.

2.1.2 Channel Profile Investigation

Following the establishment of the Study Area boundary, efforts were made to determine the unnatural sediment thickness and channel profile along each of the 14

transects. The transects were located to obtain unnatural sediment thickness information at approximately even intervals along the length of the South Ditch; the selected transect locations did not intersect the beaver dam impoundments. Measurement intervals along the transects were generally 10 feet or less.

Initially, an attempt was made to measure unnatural sediment thickness using an eight-foot long tile probe. However, this proved unsatisfactory because the probe created insufficient skin friction to allow field personnel to "feel" the denser, underlying channel bottom material. Instead, a ten-foot long, one-inch diameter polyvinyl chloride (PVC) pipe was used. This proved to be very effective as a probing tool. It was simply lowered through the unnatural sediment and, upon contact with the channel bottom material, exhibited a significant increase in resistance against further penetration. Unnatural sediment coring, as described in the next section, was used at selected locations to verify the presence of the channel bottom material. A flat-bottom aluminum row boat was used to access measuring points within the flowing portion of the South Ditch.

Figure 2-3 shows the South Ditch channel bottom profile based on the results of the unnatural sediment thickness delineation. For the purpose of comparison, Figure 2-3 also shows the results of previous unnatural sediment thickness delineation activities completed by Terra. The locations of the Terra transects are shown on Figure 2-4.

2.1.3 Unnatural Sediment Characterization

Unnatural sediment in the South Ditch was characterized using a combination of ecological and chemical testing. The ecological characterization was performed to directly measure the acute toxicity of the unnatural sediment. The chemical testing involved the characterization of metals concentrations and inorganic chemistry of the unnatural sediment.

Unnatural sediment samples were collected from along every other transect at the locations shown on Figure 2-5. The samples were subject to the following testing:

- target parameter list (TPL) including, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium and zinc to evaluate their distribution and to support the qualitative risk assessment;
- general chemistry, including, alkalinity, ammonia, pH, sulfate, sulfide, sodium, potassium, aluminum, barium, iron, silicon and total solids and mineralogical characterization to evaluate the chemical form and mobility of the TPL metals;
- target parameters by the US EPA Synthetic Precipitation Leaching Procedure (SPLP) to assess the mobility of the metals and to evaluate potential pathways of exposure;
- ecological toxicity testing to establish a toxicity gradient along the length of the South Ditch and to establish a relationship between unnatural sediment chemical quality and acute toxicity;
- Acid Volatile Sulfides/Simultaneous Extraction of Metals (AVS/SEM) and Total Organic Carbon (TOC) testing to evaluate the bioavailability of the metals in the unnatural sediment; and
- grain size distribution, unit weight, water content, percent solids, dry density, and bulk density testing to evaluate the physical characteristics of the unnatural sediment.

In addition, the following aqueous field parameters were measured in the South Ditch surface water at each unnatural sediment sampling location in order to define the general environment:

- dissolved oxygen;
- pH;
- redox potential;
- specific conductivity; and
- temperature.

A preparatory phase of unnatural sediment sampling was performed to select an optimum sampling system and technique. Investigative vertical sequence sampling was initiated after developing the sampling system and technique which consistently provided at least 60 percent unnatural sediment recovery. Several sampling systems

were pilot tested during the preparatory phase. The simplest, most effective technique was to push a PVC or acetate tube through the unnatural sediment and into the top of the channel bottom material. The top of the tube was then capped, creating a vacuum seal. The tube was then retrieved with a relatively undisturbed sample of the unnatural sediment column. Following retrieval, the cap was released and the unnatural sediment was allowed to flow out of the tube. The unnatural sediment coming out of the tube was partitioned into approximately six-inch intervals located at the top, bottom, and within the center of the unnatural sediment column on approximately two-foot centers. At some locations, it was necessary to collect additional unnatural sediment from an adjacent location in order to accumulate sufficient volume to fill the appropriate sample containers.

A minimum of one vertical sequence unnatural sediment sample was collected from near the center of each of the eight transects. The Work Plan required that "At transect locations where the channel is greater than 25 feet in width, vertical sequence unnatural sediment samples will be collected from along each transect at approximately 20-foot intervals". At transect locations where more than one sequence unnatural sediment sample was collected, the sample labels were differentiated from one another by attaching an "A" designation to one, and a "B" designation to the other. For example, the two surface unnatural sediment samples collected from transect 7 were labeled SD-007A-000 and SD-007B-000, respectively. The following table indicates the width of each transect and the locations along each transect that the samples were collected. The table indicates that at transects 7 and 13, samples were collected at 22 and 21 feet from the margin of the transect, respectively. Additional samples were not collected at these two transects since the resulting spacing barely exceeded the approximate 20-foot spacing required by the Work Plan.

Transect Number	Transect Width (ft)	Location of "A" Sample	Location of "B" Sample
1	11	6' west of east side	
3	23	11' east of west side	
5	23	11' east of west side	
7	34	5' east of west side	12' east of west side
9	32	28' east of west side	18' east of west side
11	12	6' east of west side	
13	45	12' west of east side	24' west of east side
14	8	13' north of south side	

Each of the vertical sequence unnatural sediment samples was analyzed for the TPL. The sample obtained from the approximate center of each vertical sequence column was also analyzed for general chemistry parameters and leached using the SPLP methodology. The resulting leachate was then analyzed for the TPL. Table 2-1 presents a summary of the sample designations, locations, depth intervals, and analyses performed.

In addition to the vertical sequence samples, surficial unnatural sediment samples (0 to 6 inches) were collected from each of the vertical sequence sample transect locations. At each of these transect locations, three discreet samples were collected from along the length of the transect. The three samples were then consolidated in a decontaminated, stainless steel mixing bowl. Each composite sample was analyzed for AVS/SEM, mineralogical parameters, and subjected to ecological toxicity testing.

Ecological toxicity testing was performed using a modified, four-day version of the ten-day ASTM Method E-1706-95a. Midge larva (*Chironomus tentans*) and the scud (*Hyalella azteca*) were used in the test because they are representative of the Study Area.

2.1.4 Background Sediment Quality Investigation

Sediment samples were collected at four background locations and analyzed for the TPL target parameters. In addition, two of the samples were analyzed for general chemistry parameters and subject to toxicity testing. These data were used to establish background levels for the TPL and general chemistry parameters and for background sediment toxicity.

Each of the four background sediment samples were collected from within Turner Lake, at the approximate locations shown on Figure 2-6. The same equipment and techniques used to collect unnatural sediment in the South Ditch were used to collect the background sediment samples in Turner Lake. Because the lake was frozen, however, an approximate six-inch diameter hole was first cut in the ice at each sample location. Background sediment samples were then collected from the upper one to two feet of the sediment column.

2.1.5 Physical Characterization

Following collection of samples for chemical analysis, unnatural sediment samples were collected for the purpose of characterizing physical properties. Shelby tube and bag samples were collected at transects 7, 9, and 11. Each sample was tested for moisture content, density, and grain size distribution. In addition, the sample collected from transect 7 was tested for Atterberg limits.

2.2 Channel Bottom Sampling

Channel bottom samples were collected at the same eight transect locations where unnatural sediment samples had been obtained. Each sample was analyzed for the TPL to determine the extent, if any, of impact associated with the overlying unnatural sediment. In addition, two of the channel bottom samples were analyzed for general chemistry parameters.

The channel bottom samples were collected following collection of vertical sequence unnatural sediment samples at each transect location.

Each channel bottom sample was collected inside a temporary casing in order to minimize contact between the sampling tube and the overlying unnatural sediment. The temporary casing consisted of either three or four inch diameter PVC pipe. One end of the casing was sealed with duct tape prior to advancing it through the unnatural sediment. The temporary casing was pushed through the unnatural sediment (sealed end-first) until the channel bottom material was encountered. The casing was then driven between six inches and one foot into the channel bottom material, until firmly seated, to create a satisfactory seal between the unnatural sediment and channel bottom material. A tile probe was then used to pierce the duct tape seal on the bottom of the casing. Following verification that a satisfactory seal had been made, the sampling tube was lowered inside the casing and then driven into the channel bottom material to obtain the sample. A sample from the top of the channel bottom material was not collected because a satisfactory seal could not be obtained without driving the casing at least six inches into the channel bottom material. The channel bottom material selected for analysis at each location was from the lower six inch interval of a 1-foot sample. In general, the channel bottom material sample was obtained from between 1.5 and 2-feet below the channel bottom/unnatural sediment interface.

2.3 South Ditch Hydrogeologic Investigation

A series of three temporary piezometers were installed in the channel bottom material to characterize the relationship between surface water and groundwater in the vicinity of the Study Area. Groundwater levels were also measured in wells located near the Study Area as part of the characterization.

2.3.1 Temporary Piezometer Investigation

The temporary piezometer investigation was initiated following the unnatural sediment delineation, profiling and sampling, and channel bottom sampling activities. Three

temporary piezometers were installed along the length of the South Ditch, at the locations shown on Figure 2-7. The depths were chosen to avoid the possibility of bridging a confining unit. Each piezometer was constructed of five foot sections of one inch diameter PVC well screen and riser pipe.

Each piezometer was constructed within a PVC casing in order to minimize contact between the screen section and the unnatural sediment. The casing was installed in the same manner as described in Section 2.2. Following installation of the casing, the piezometer assembly was lowered inside the casing and then driven into the channel bottom material. Each piezometer was driven to ensure that the screen was set into the channel bottom material. However, care was taken during piezometer installation to avoid breaching the Peat. The annulus between the piezometer riser and the casing was subsequently filled with hydrated, granular bentonite. Piezometer construction diagrams for TP-1, TP-2, and TP-3 are provided as Figures 2-8, 2-9, and 2-10, respectively.

Temporary piezometers TP-1 and TP-3 were installed to the target depth of approximately five feet below the channel bottom/unnatural sediment interface. Both TP-1 and TP-3 were installed with a minimum of three feet of screened interval open to the channel bottom material. Due to resistance encountered when advancing temporary piezometer TP-2 through the channel bottom material, this piezometer could not be advanced beyond approximately a depth of three feet below the channel bottom/unnatural sediment interface. TP-2 has approximately one foot of screened interval open to the channel bottom material. Because all three piezometers were advanced manually without observation of the exact depth and nature of the channel bottom material, the composition of the native material within the screened interval could not be verified.

The location of each piezometer was measured relative to a surveyed transect location endpoint. Piezometer elevations were determined with a tripod and level, using a temporary benchmark located within the Study Area.

2.3.2 Groundwater Level Measurements

Surface and groundwater levels were measured on August 20, 1996. Surface water elevations in the South Ditch were determined at staff gauge SG-3, located at the north end of the South Ditch, and adjacent to each piezometer.

Groundwater levels were measured relative to the top of riser at each temporary piezometer.

3.0 RI RESULTS

The principal activities performed during the Focused RI consisted of delineating the horizontal and vertical extent of the unnatural sediment; characterizing its physical properties, mineralogy, total and leachable metals content, and its ecological toxicity; and evaluating the metals loading to the underlying channel bottom material. The following sections present the results of these activities.

3.1 Unnatural Sediment Extent and Physical Characteristics

Field investigations and laboratory testing were performed during the unnatural sediment delineation, channel profile characterization, and unnatural sediment characterization tasks of the Focused RI in order to estimate the volume of the unnatural sediment and evaluate its physical characteristics.

3.1.1 Extent and Volume of Unnatural Sediment

The approximate horizontal extent of the unnatural sediment was delineated from the head of the South Ditch to its mouth at Lake DePue using 1992 and 1995 aerial photographs of the Site. Figures 3-1a and 3-1b show the 1992 and 1995 aerial photographs, respectively, used to delineate the extent of the unnatural sediment. Figures 3-1a and 3-1b include annotations indicating extent of unnatural sediment.

The 1992 aerial photograph shows DePue Lake, Marquette Street, nearby residences, the former settling ponds, and the South Ditch. The extent of unnatural sediment within the South Ditch is clearly indicated by its light colored appearance. This light colored appearance extends from the head of the ditch to beaver dam six. The 1995 aerial photograph shows that the water level within DePue Lake is significantly higher than in the 1992 aerial photograph. As a result, the water level within the South Ditch obscured the view of the unnatural sediment. Consequently, the 1992 exposure was used as the principal aerial photograph for delineating the extent of the unnatural sediment. Figure 3-2 shows the results of the unnatural sediment delineation.

During the channel profile investigation, the unnatural sediment thickness was determined at fourteen transects by probing (see Section 2.1.2). Table 3-1 shows the results of the Channel Profile Investigation. From these data, cross-sections of the unnatural sediment thickness were prepared. Figure 2-3 shows each of these cross-sections. In transects 1 through 5, unnatural sediment thickness ranged from zero at the channel edges, to a maximum of approximately five feet near the center of the channel. Unnatural sediment thickness in the east-west channel leg (transect 14) ranged from zero to a maximum of approximately three and one-half feet. Unnatural sediment thickness in the southerly, meandering portion of the channel (transects 6 through 13) was more variable, with the maximum thickness at each transect varying from four feet to approximately seven feet near Lake DePue. As discussed in Section 2.1.2, transect locations for the Channel Profile Investigation were selected to obtain data on unnatural sediment thickness at approximately evenly spaced intervals along the South Ditch. As a result, no transects were completed directly upstream of any of the six beaver dams. Consequently, data on the unnatural sediment thickness directly upstream of the beaver dams was not collected. It is expected, however, that the unnatural sediment will be somewhat thicker upstream of the beaver dams.

The mean unnatural sediment thickness for the upper third (TR1-TR4), the middle third (TR5-TR9, and the lower third (TR10-TR13) are as follows:

Upper Third:	3.98 feet
Middle Third:	4.31 feet
Lower Third:	5.61 feet.

These data indicate that the unnatural sediment wedge is generally thicker in the downstream direction.

This general increase in unnatural sediment thickness toward Lake DePue is likely attributable to:

i) the original topography of the channel bottom material, and;

ii) more frequent inundation of the southern end of the Study Area during flooding of Lake DePue, resulting in more silt deposition.

As will be discussed later in Section 3.2.3, the unnatural sediment composition near the southern end of the Study Area showed reduced metal concentrations. This indicates that the thickening wedge of unnatural sediment near Lake DePue was due, in part, to an increase in lacustrine-derived silts and clays.

To evaluate potential temporal changes in unnatural sediment thickness and channel profile configuration, a comparison was made between the unnatural sediment channel profiles completed during this investigation with those previously completed by Terra. Figure 2-3 compares the two sets of profiles. Each profile set was arranged on the figure according to the northerly location of the profile center. As such, the relative north-south position of each profile is depicted on the figure. Figure 2-3 shows that the RI profiles complemented the Terra profiles, generally filling in some of the spatial gaps along the length of the South Ditch. Although the Terra profiles are more generalized than the RI cross-sections, a comparison shows that, for the comparable portions, the channel profile configuration has changed little during the nearly two-year period separating the two studies.

Based on the data compiled from the two investigations, it was possible to develop an estimate of the unnatural sediment volume in the Study Area. The unnatural sediment volume was calculated using the following procedure:

i) The average depth of the unnatural sediment at each transect shown in Figure 2-3 was determined based on the results from the depth profiling. This procedure generated the average depths indicated on Table 3-1

ii) The horizontal or map-view area of the unnatural sediment between transects was determined using the Study Area dimensions shown on Figure 2-1. This

area calculation was performed using AUTOCAD and the results are also shown on Table 3-1.

iii) The volume of unnatural sediment between transects was then calculated assuming that the average depth of the unnatural sediment from each transect extends to the midpoint between transects. The AUTOCAD program was then used to calculate the unnatural sediment volumes, which are shown on Table 3.1.

Based on this information, the unnatural sediment volume in the Study Area was estimated to be approximately 7,900 cubic yards. Table 3-1 shows the unnatural sediment volume calculation. Given the necessity of making simplifying assumptions concerning the thickness of the unnatural sediment along the length of the Study Area, there is some degree of uncertainty in the volume calculations presented. Thus, the unnatural sediment volume calculation should be considered an approximate value for the purposes of this RI.

3.1.2 Physical Description

The unnatural sediment consisted of a relatively homogeneous mass of material which was distinctly different from the native, channel bottom material. In general, the unnatural sediment column varied from a floc-like precipitate at the surface to a very fine to fine grained mass with depth. The floc-like layer ranged from four to six inches in thickness. The exact thickness was difficult to determine because the material was easily disturbed. Several distinct colors were observed within the unnatural sediment column, although there seemed to be no consistent color pattern or stratigraphic divisions with depth. Colors varied from pastel lime green in the floc-like surface material, to a dark lime green. Isolated lenses in the unnatural sediment column exhibited a distinctive red-orange coloring. In general, the samples of the unnatural sediment collected near the mouth of the South Ditch contained a higher percentage of lacustrine sediment. Although the unnatural sediment was treated as one homogeneous unit, the noted increase in lacustrine silts and clays closer to Lake DePue suggests that the content of unnatural material decreases in the downstream reaches of the Study Area.

The channel bottom material generally consisted of the Peat which ranged in color from dark gray to black. The Peat contained an increasingly greater fraction of detrital material toward the bottom. At transect 5, the channel bottom material consisted of fine grained sand and gravel. Since the vertical profile sampling only extended two feet into the channel bottom material, no definitive statement can be made concerning the potential presence or absence of the Peat at Transect 5. It is possible that excavation conducted during the construction of the South Ditch may have removed the Peat locally. However, the origin (i.e., fill versus natural material) and stratigraphic relationships (i.e., is the recovered material underlain by the Peat) are unknown and beyond the scope of the Focused RI.

3.1.3 Physical Properties of the Unnatural Sediment

Some of the physical properties of the unnatural sediment were evaluated from various samples collected from the Study Area. Shelby tube and bag samples were collected for physical property determination from transects 1, 3, 5, 7, 9, 11, and 13. Testing was performed on samples from transects 7, 9, and 11. Samples from the other transects were not tested because their high water content precluded proper preservation (i.e., sealing the ends of the Shelby tubes). Unit weight, dry density, percent solids, water content, and grain size distribution were determined for each sample. In addition, Atterberg limits were determined for the sample collected from transect 7. Table 3-2 summarizes the results of the physical testing of the unnatural sediment. Appendix A presents the laboratory testing reports.

The results of the moisture content testing indicate that the unnatural sediment is characterized by consistently low solids, ranging between 24 and 27 percent. As a result of low percent solids, dry densities are also low, ranging between 17 and 18 lbs/ft^3. Atterberg limit testing indicates the unnatural sediment is highly plastic having a liquid limit of 134 and a plasticity index of 25. Each of the three samples exhibited relatively consistent grain size distributions, having no fraction coarser than medium sand with the percentages of fines ranging between 67 and 76 percent. These results confirm the observed floc-like, or precipitate nature of the unnatural sediment.

3.2 Unnatural Sediment Composition and Chemistry

The unnatural sediment chemistry and composition were based on the analytical results of the following three sets of samples:

- 32 unnatural sediment samples collected from eight transects across the South Ditch;
- 11 channel bottom samples collected from eight transects across the South Ditch; and
- four background sediment samples collected from Turner Lake.

As indicated on Table 2-1, each unnatural sediment and background sediment sample was analyzed for the fourteen metals on the TPL. Unnatural sediment samples collected from the interval just below the surface, two channel bottom samples, and two background sediment samples were also analyzed for general chemistry parameters. These samples were also subject to an SPLP extraction performed at a pH intended to simulate leaching resulting from acid rainfall (approximate pH of 4.2). The resulting aqueous extract was analyzed for the same fourteen TPL metals. Another extraction, using a lower pH solution, was performed on the unnatural sediment. This extraction was analyzed to determine the concentration of acid volatile sulfides and simultaneously extracted metals (AVS/SEM). The results of this analysis provide an indication of the bioavailability of the metals. In addition, x-ray diffraction and scanning electron microscopy were performed on the unnatural sediment for mineralogical phase identification.

The testing results are described in the following sections. Unnatural sediment and channel bottom samples from the same locations were also analyzed to determine ecological toxicity for representative benthic invertebrates. The ecological toxicity testing is discussed in Section 3.2.7.

3.2.1 Field Screening Parameters

Prior to collecting unnatural sediment samples, a surface water sample was retained at each transect location and subjected to measurement of various field screening parameters. These included pH, temperature, specific conductivity, redox potential, and dissolved oxygen. The following table summarizes the results of these field measurements.

Transect Location	pH (stnd. units)	Temperature (degrees C)	Spec. Cond. (mV/cm)	Redox Pot. (mV)	Diss. Oxygen (mg/L)
1	6.79	7.2	1.606	-4	8.0
3	6.75	5.4	1.220	-24	8.0
5	7.08	5.3	1.320	-53	6.0
7	7.26	6.9	0.000	-82	6.0
9	6.21	6.1	0.064	-228	6.0
11	5.29	1.2	2.140	-329	2.4
13	6.94	2.0	0.000	-169	3.2
14	6.45	9.4	0.990	-7	7.0

Values of pH generally ranged from approximately 6.2 to 7.1. An anomalously low pH value of 5.29 was measured at transect 11, however. Temperatures varied from 1.2 to 9.4 degrees Celsius. This is most likely attributable to the sample residence time in the sample container prior to temperature measurement. The extreme cold and wind conditions which existed during part of the field program undoubtedly affected the temperature measurements. Specific conductivity values, which are a function of the dissolved ion concentration, ranged from 0.0 to over 2.0 mV/cm. No trend was readily apparent. In general, the highest values were measured near the head of the South Ditch (transects 1, 3, 5, and 14), although the highest value was in fact measured further downstream, at transect 11. Field redox potential is a measure of the likelihood for oxidizing or reducing conditions to exist within a system. Negative potentials, as measured here, indicate that the environment is relatively reducing. It appears as if redox potentials became more negative further downstream, indicating that conditions may be increasingly reducing closer to Lake DePue. Dissolved oxygen, also may be indicative of the oxidation-reduction potential, but does not constitute a direct measurement of the redox potential. Dissolved oxygen also generally decreased further

downstream. At each transect, the dissolved oxygen concentration was well below the expected equilibrium value with respect to atmospheric oxygen. Decreasing concentrations of dissolved oxygen are indicative of less oxidizing, or more reducing environments.

3.2.2 General Chemistry

Twelve unnatural sediment, two channel bottom, and two background samples were analyzed for general chemistry parameters. In addition, two duplicate unnatural sediment samples and three rinsate samples were analyzed for quality control purposes. The general chemistry analyses consisted of anions (i.e., aqueous alkalinity and sulfate, nitrogen-ammonia, and sulfide), TOC, cation exchange capacity (CEC), cations (i.e., calcium, magnesium, potassium, sodium, aluminum, barium, iron, and silicon), pH, and percent solids. As indicated on Table 2-1, unnatural sediment samples were collected from the surface and at depths of 1.5 to 5.5 feet below the surface. The channel bottom material selected for analysis at each location was from the lower six inch interval of a 1-foot sample. In general, the channel bottom material sample was obtained from between 1.5 and 2-feet below the channel bottom/unnatural sediment interface. Background sediment samples in Turner Lake were collected from the top one-foot of material. The general chemistry results are summarized in Table 3-3. Table 3-4 provides a legend for qualifiers used on the unnatural sediment chemistry summary tables. Analytical results are provided on a dry-weight basis. The complete laboratory analytical reports are provided in Appendix B.

Due to the unusually high moisture content of the samples, insufficient solid volume was available for determination of cation-specific cation exchange capacities, sulfide, and nitrogen-ammonia for the unnatural sediment samples from transects 1, 3, and 5.

Unnatural sediment pH values ranged from 6.64 (transect 1) to 7.89 (transect 11). Channel bottom material pH values ranged from 7.29 (transect 5) to 8.06 (transect 13). Background pH values measured in background sediment samples collected from Turner Lake were 7.52 and 7.66. In general, it appears that the unnatural sediment pH

was slightly depressed towards the head of the South Ditch as compared to the background sediment samples.

Based on the general chemistry results, the most abundant metal in the unnatural sediment, channel bottom material, and background sediment is iron. Iron concentrations in the unnatural sediment ranged from 24,000 mg/kg (transect 14) to 443,000 mg/kg, (or about 44 percent in transect 3). The mean iron concentration in the unnatural sediment was 81,733 mg/kg. Iron concentrations in the channel bottom material were 70,000 mg/kg (transect 5) and 27,000 mg/kg (transect 13). Iron concentrations in both background samples were 27,000 mg/kg.

The second most abundant metal in the unnatural sediment, channel bottom material, and background sediment is calcium. Calcium concentrations in the unnatural sediment ranged from 190 mg/kg (transect 7) to 140,000 mg/kg (transect 3), with a mean of 26,456 mg/kg. Calcium concentrations in the channel bottom material were 7,100 mg/kg (transect 13) and 36,000 mg/kg (transect 5). Calcium concentrations in the background sediment were 18,000 and 26,000 mg/kg.

Potassium concentrations in the unnatural sediment ranged from 810 mg/kg (transect 14) to 8,100 mg/kg (transect 7). Channel bottom potassium concentrations were slightly less than in the background sediment. Sodium concentrations in the unnatural sediment ranged from 250 mg/kg (transect 13) to 11,000 mg/kg (transect 3). Channel bottom concentrations were similar to the background sediment. Barium concentrations in the unnatural sediment ranged from 193 mg/kg (transect 14) to 4,140 mg/kg (transect 3), and silicon concentrations in the unnatural sediment ranged from 2,300 mg/kg (transect 13) to 55,800 mg/kg (transect 3).

Sulfate concentrations in the unnatural sediment ranged from 463 mg/kg (transect 14) to 87,100 mg/kg (transect 3), with a mean value of 17,384 mg/kg. Sulfate results for the channel bottom material were 3,790 mg/kg (transect 13) and 1,710 mg/kg (transect 5). Sulfate was not detected in concentrations above the instrument detection limit in the background sediment.

Sulfide results for the unnatural sediment ranged from below the instrument detection limit (i.e., < 4.4 mg/kg at transect 7) to 820 mg/kg (transect 13). The mean sulfide concentration was 120 mg/kg. As noted, however, insufficient sample volume was available to determine the sulfide concentrations from samples collected at transects 1, 3, and 5. Sulfide concentrations in the channel bottom material were 1.7 mg/kg (transect 13) and 9.2 mg/kg (transect 5). Sulfide concentrations in the background sediment were 45 mg/kg and 122 mg/kg.

TOC concentrations in the unnatural sediment ranged from 1,100 mg/kg (transect 14) to 37,000 mg/kg (transect 3), with a mean value of 8,853 mg/kg. TOC concentrations in the channel bottom material were 2,500 mg/kg (transect 13) and 3,600 mg/kg (transect 5). Both background sediment samples had TOC concentrations of 2,700 mg/kg.

Alkalinity was determined in a 10% solution of solid material. The unnatural sediment alkalinity ranged from 1,310 mg/kg (transect 9) to 45,400 mg/kg (transect 3). The mean unnatural sediment alkalinity value was 10,004 mg/kg. The channel bottom alkalinity values were 1,580 mg/kg (transect 5) and 2,200 mg/kg (transect 13). Background sediment values were 1,880 mg/kg and 2,650 mg/kg.

Nitrogen-ammonia results for the unnatural sediment ranged from 313 mg/kg (transect 9) to 533 mg/kg (transect 11), with a mean value of 425 mg/kg. Nitrogen-ammonia values for the channel bottom material were 44.3 mg/kg (transect 5) and 36.7 mg/kg (transect 13). Values of nitrogen-ammonia for the background sediment were 200 mg/kg and 80.3 mg/kg.

The following table compares the concentration ranges of general chemistry parameters for the unnatural sediment and channel bottom material with the background sediment.

Parameter	Units	Background Sediment Concentration Range	Channel Bottom Concentration Range	Unnatural Sediment Concentration Range
pH	std.	7.52 - 7.366	7.29 - 8.06	6.64 - 7.89
iron	mg/kg	27,000	27,000 - 70,000	24,000 - 443,000
calcium	mg/kg	18,000 - 26,000	7,100 - 36,000	190 - 140,000
magnesium	mg/kg	9,700 - 15,000	6,900 - 8,800	170 - 41,000
potassium	mg/kg	2,300 - 2,600	1,200 - 2,200	810 - 8,100
sodium	mg/kg	170 - 190	130 - 640	250 - 11,000
aluminum	mg/kg	18,000 - 19,000	8,400 - 16,000	6,000 - 47,000
barium	mg/kg	140 - 150	71 - 337	193 - 4,140
silicon	mg/kg	2,600 - 3,500	1,500 - 2,700	2,300 - 55,800
sulfate	mg/kg	<100	1,710 - 3,790	463 - 87,100
sulfide	mg/kg	45 - 122	1.7 - 9.2	ND - 820
TOC	mg/kg	2,700	2,500 - 2,200	1,100 - 37,000
alkalinity	mg/kg	1,880 - 2,650	1,580 - 2,200	1,310 - 43,400
N-ammonia	mg/kg	80.3 - 200	36.7 - 44.3	313 - 533

Based on these results, it appears as if most of the general chemistry parameters are elevated in the unnatural sediment as compared to the background sediment. Notable exceptions are magnesium, which varied little from background, and aluminum, for which concentrations in the unnatural sediment were found to be less than in the background sediment. Sodium concentrations appear to be elevated, and pH depressed, only in the unnatural sediment collected near the head of the South Ditch. Channel bottom material concentrations were generally equal to, or less than, background sediment concentrations. Two exceptions included iron and sulfate. Sulfate concentrations in the channel bottom material generally exceeded background sediment concentrations in all samples. Iron concentrations in the channel bottom material only

exceeded background values at transect 5. At this location, the channel bottom material was found to consist of coarse grained sand and gravel as compared to fine grained, organic material (the Peat) which was found at all other transect locations.

Examination of the redox pair sulfate/sulfide provides a general indication of whether or not the environment is reducing or oxidizing, assuming equilibrium conditions. In the case of the unnatural sediment, the amount of sulfate relative to sulfide suggests that a more oxidizing environment is present relative to what the field parameters indicated.

Although fewer background samples were analyzed in comparison to investigative samples, it appears that the measured parameters for the investigative population have greater variance than the parameters for the background population. This suggests a heterogeneous quality to the unnatural sediment.

No detections occurred in the analytical results for the rinsate samples, indicating that decontamination procedures adequately prevented potential sample cross-contamination.

3.2.3 Target Parameter List Metal Concentrations

Thirty-seven unnatural sediment samples, including four duplicates, eleven channel bottom samples, including one duplicate, and four background sediment samples from Turner Lake were analyzed for the fourteen metals on the TPL. Table 3-5 summarizes these results. The laboratory analytical report is included in Appendix C.

Concentration ranges for all of the metals detected in the unnatural sediment samples are listed in the following table.

Metal	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Arsenic	7.8	82
Beryllium	0.38	2.8
Cadmium	32.4	910

Metal	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Chromium	6.2	78.2
Cobalt	8.1	70.2
Copper	144	97,700
Lead	125	3,440
Manganese	433	3,130
Mercury	0.2	4.6
Nickel	11.6	69.4
Selenium	0.57	4.6
Silver	1.4	144
Vanadium	5	38
Zinc	3,840	204,000

All the metal concentrations in the unnatural sediment exceeded those found in the background sediment, with the exception of chromium, nickel, and vanadium. These three metals were found at similar concentrations to background. Background metal concentrations were also exceeded at all the channel bottom sampling locations, including transect 1 (copper and zinc), transect 3 (copper and zinc), transect 5 (arsenic, cadmium, cobalt, copper, lead, manganese, mercury, selenium, silver, and zinc), transect 7 (cadmium, cobalt, copper, silver, and zinc), transect 9 (copper, silver, and zinc), transect 11 (zinc), transect 13 (cobalt, manganese, and mercury), and transect 14 (manganese and mercury).

Figures 3-3a, b, c, and d show plots of the concentration of zinc and copper in samples collected from each depth interval within the unnatural sediment column and the channel bottom material, respectively, versus the horizontal distance downstream of the outfall. Figures 3-4a, b, c, and d show plots of the concentration of lead, cadmium, and arsenic in samples collected from each depth interval within the unnatural sediment column and the channel bottom material, respectively. Figures 3-5a through k and Figures 3-6a through k show plots of the concentrations of the same metals versus depth for each sampling location. These plots suggest that the overall concentrations of zinc, copper, lead, and cadmium generally decline along both the length of the South Ditch away from the outfall and with depth. However, the concentration decline for each constituent is irregular, and local increases in concentrations occur along the length of the South Ditch. The configuration of the concentration graphs for zinc, cadmium, and

copper appear to be particularly similar. Lead concentrations decline along the length of the South Ditch at each sample depth, but this trend occurs more irregularly than for the other metals. Arsenic concentrations, on the other hand, appear to be relatively constant along the South Ditch length.

3.2.4 SPLP Results

Fifteen unnatural sediment samples, including three duplicates, were collected from just below the surface of the unnatural sediment column and analyzed for the fourteen metals on the TPL in accordance with the SPLP procedure. These results are summarized in Table 3-6. The laboratory analytical report is included as Appendix B. SPLP analyses were not conducted on the channel bottom or background sediment samples. The following table summarizes the minimum and maximum concentrations for each metal found in the unnatural sediment extract.

Metal	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)
Arsenic	<0.005	0.163
Beryllium	<0.005	<0.005
Cadmium	<0.01	0.37
Chromium	<0.04	<0.04
Cobalt	<0.1	0.213
Copper	0.025	1.63
Lead	<0.005	0.116
Manganese	0.031	13
Mercury	<0.0004	<0.0004
Nickel	<0.05	0.102
Selenium	<0.005	0.035
Silver	<0.04	<0.04
Vanadium	<0.05	<0.05
Zinc	0.63	116

Beryllium, chromium, mercury, silver, and vanadium were not detected in the SPLP extract. Lead was detected in extract samples from transects 3, 9, 11, 13, and 14. Arsenic was detected in extract samples from transects 3, 9, 11, and 13. Cobalt and selenium were found only in the extract sample from transect 1. Nickel was found only in the extract sample from transect 3. The remaining metals, cadmium, copper, manganese, and zinc,

were detected in the extract sample collected from each of the transect locations. Zinc, manganese, and copper were detected in the SPLP extract, in descending order of concentration, in the part-per-million (ppm) range. However, if considering the ratio of extracted concentration to total concentration, a greater percentage of manganese was recovered in the SPLP extract than zinc in each of the samples. This suggests that the rank of leachability, in descending order is manganese, zinc, cadmium, and copper.

The most significant result from the SPLP testing was the very low leachate concentration of the TPL metals. Comparing the total metals concentrations of the unnatural sediment with the SPLP concentrations shows that less than 1 percent of the metals was leached using the SPLP leach solution which has an acidic pH of approximately 4.2. Given that the observed pH in the unnatural sediment ranges from 6.64 to 7.89 (Table 3-2) and that the solubility of the metals typically decreases with an increase in pH, it is likely that the metals would be even less leachable under typical conditions observed at the Site. In summary, the SPLP testing results indicate that the unnatural sediment contained within the South Ditch is resistant to leaching under typical Site conditions.

3.2.5 AVS/SEM Results

AVS/SEM analyses were performed on eight unnatural sediment samples. No background sediment, channel bottom material, or quality control samples were analyzed. Each of the unnatural sediment samples was collected from the surface. Table 3-7 summarizes the results of the AVS/SEM analyses. The laboratory analytical report is included as Appendix D. The following table summarizes the minimum and maximum concentrations for each of the AVS/SEM parameters found in the unnatural sediment.

Analyte	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Acid Volatile Sulfides	<15.1	424
Arsenic	5.2	12.4
Beryllium	0.57	1.1

Analyte	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)
Cadmium	86	390
Chromium	2.9	10.5
Cobalt	13.6	35
Copper	22,000	67,000
Lead	176	520
Manganese	470	1,620
Mercury	0.045	0.112
Nickel	16.7	31
Selenium	not detected	not detected
Silver	2.3	2.3
Vanadium	5	12.8
Zinc	39,000	210,000
Solids, Percent	12.7	31.7

Acid volatile sulfides were detected only in the unnatural sediment sample collected from transect 14.

3.2.6 Mineralogical Testing Results

Unnatural sediment samples were collected for mineralogical testing from transect locations 1, 3, 5, 7, 9, 11, 13, and 14. Each sample was subjected to mineralogical testing with the objectives of identifying the composition and structure of crystalline precipitates comprising the unnatural sediment. X-ray diffraction (XRD) and sequential acid dissolution (SDA) with XRD and inductively coupled plasma (ICP) chemical analysis techniques were used to meet these objectives. In addition, the samples were subjected to scanning electron microscopy-energy dispersive X-ray (SEM-EDX) analyses to identify mineral forms. The laboratory reports for the mineralogical testing are presented in Appendix E.

Identification of the mineral phases in the unnatural sediment, and determination of their relative quantities, was to be performed by a combination of techniques consisting of x-ray diffraction and sequential acid dissolution, respectively. The x-ray diffraction was to be used to identify specific mineral phases in the bulk unnatural sediment and the residual unnatural sediment following each sequential acid dissolution. The sequential acid dissolutions involved exposing unnatural sediment to acetic acid

(typically used for mineralogic studies of carbonate rocks because it acts preferentially on carbonate minerals) for increasingly longer time periods. By comparing the ratios of dissolved metals from each time step dissolution, and noting the disappearance of mineral phases from the x-ray diffraction data, the mineral phases and relative quantities were to be deduced. However, during the initial dissolution in 33% acetic acid, much of solid material unexpectedly dissolved. This result greatly limited the ability to determine the relative quantities of mineral phases because most of the metals dissolved simultaneously. Therefore, the results of the mineralogical study do not provide reliable data on the relative percentages of mineral phases. However, the rapid dissolution of the bulk of the unnatural sediment mass during the acetic acid dissolution indicates that the unnatural sediment is largely composed of gelatinous, amorphous and poorly crystallized phases. Based on the high metal content (general chemistry results), uniform distribution of fine-grained copper, iron, and zinc indicated by the SEM-EDX results, and the gelatinous character of the unnatural sediment, metallic hydroxides may comprise a significant portion of the amorphous material.

The x-ray diffraction results, performed after the sequential acid dissolution, indicate the presence of several identifiable phases in the residual non-amorphous materials. Specifically, smithsonite ($ZnCO_3$), zinc phosphate ($Zn_3(PO_4)_2 \bullet 4H_2O$), and anhydrite/gypsum ($CaSO_4$)/($CaSO4 \bullet 2H_2O$) were present (Lowry, 1996) (Hughes, 1996). Smithsonite typically is found to form as reniform (radiating needle masses) or as granular masses. Information on the structure of zinc phosphate is limited. However, its structure most likely resembles other phosphate minerals such as apatite. Apatite commonly forms prismatic crystals but tabular crystals are known to occur. The solid zinc phases depicted on the micrographs typically formed prismatic, tabular, and granular solids with smoother textures than other grains in the field of view. These textural features imply that the zinc solid phases have not been subjected to much transport and were formed in place.

The naturally occurring minerals identified in the samples in approximate order of abundance are quartz and illite at roughly equal percentages, dolomite, chlorite, expandable clays, plagioclase, K-feldspar, and calcite. In addition, gypsum and iron

oxides were also identified in the SEM-EDX study. The shape of natural minerals typically was rounded and granular looking. This implies that these minerals were subject to transport and were not formed in the unnatural sediment. An exception to this are the carbonate minerals which showed rhombic form. This is either due to in-situ formation or excellent cleavage common to carbonates. The percent of expandable clays appears to increase downstream indicating a higher proportion of fine-grained unnatural sediment in the stream load.

There is additional evidence which indicates that the unnatural sediment was formed in-place and not transported and deposited. The following summarizes this evidence:

- Based on the results of the acidification and SEM/EDX study, much of the unnatural sediment is amorphous. The amorphous material lacks strength and its consistency is associated with a high water content; it lacks the strength to have been transported.
- unnatural sediment is only located in the South Ditch. No other areas on or around the Site has this material.

The results also appear to indicate that copper and iron precipitate prior to zinc. This is consistent with Figure 3-3 which shows that zinc concentrations in the unnatural sediment generally increase from transect 1 to transect 3, while copper concentrations generally decrease from transect 1 to transect 3. These observations suggest that a high percentage of the metals in the stream load are released upstream, and that stream water quality, in terms of dissolved metal content, improves further downstream.

These observations suggest that precipitation is a mechanism for dissolved metal content reduction in the South Ditch even though some dissolved metal concentrations will remain in the surface water discharge to the lake. However, the actual water quality of the South Ditch surface water is unknown due to lack of analytical data.

3.2.7 Ecological Toxicity Testing Results

Unnatural sediment samples collected from transect locations 1, 3, 5, 7, 9, 11, 13, and 14 and two background sediment samples collected from Turner Lake were subjected to ecological toxicity testing. *Chironomus tentans* and *Hyalella azteca* were chosen for the test because they are representative of the benthic invertebrates that would inhabit environments similar to the Study Area. A modified form of test method ASTM E1706-95a was used for the test. Specifically, the test was run for a four-day period instead of the ten-day period specified in the test. The results of the ecological toxicity testing are summarized on Tables 3-8 and 3-9 for *Chironomus tentans* and *Hyalella azteca*, respectively. The laboratory analytical report is included as Appendix F.

One hundred percent mortality for *Chironomus tentans* was observed in all of the unnatural sediment samples, except for that collected from transect 13, furthest from the South Ditch outfall, which exhibited 85 percent mortality. All the unnatural sediment samples exhibited mortality which was statistically greater than the control sample for the group, which exhibited ten percent mortality. Of interest, however, were the two background sediment samples collected from Turner Lake, in which mortality after four days was 22% and 35% which exceeded the control mortality by a statistically significant margin in both samples.

One hundred percent mortality for *Hyalella azteca* was observed in all of the unnatural sediment samples. As with *Chironomus tentans*, statistically significant mortality greater than the control sample was also observed in the two background samples, although percent mortality was less (22% and 23%).

Results of the ecological toxicity testing suggest that the unnatural sediment does present an acutely toxic environment to the two test organisms. The acute toxicity may be the result of the metals present in the unnatural sediment as documented in this report. It is possible, however, that the unnatural sediment toxicity is partially a function of the floc-like nature of the material which impacts survival.

3.3 Floodplain Delineation

One of the specific objectives of the Focused RI was to define the floodplain/floodway boundaries and lowlands which may be impacted under various remedial alternatives. The floodplain boundary established by the Federal Emergency Management Agency (FEMA) is that related to a 100-year flood. A 100-year flood is one that has an annual recurrence interval of one in one hundred.

In the DePue area, the 100-year flood plain boundary is related to water fluctuations in Lake DePue and occurs at an elevation of 464 ft. msl. The location of the local 100-year floodplain is shown on Figure 3-7. The South Ditch and the surrounding lowlands are located within the 100-year floodplain. Ground surface adjacent to the South Ditch occur at elevations ranging between 441 and 450 ft. msl. Other portions of the Site are located above the 100-year floodplain.

3.4 Temporary Piezometer Investigation

Three temporary piezometers (TP-1, TP-2, and TP-3) were installed along the South Ditch at the locations shown on Figure 2-7 following channel profiling and unnatural sediment sampling activities. On August 20, and October 30, 1996, groundwater levels were measured in the temporary piezometers and previously installed monitoring wells located south of Marquette Street (HS9(s), HS10(s), HS11(s), HS12(s), and HS13(i)). In addition, surface water levels were measured in the South Ditch at staff gauge SG-3, and adjacent to each temporary piezometer, in order to evaluate whether vertical hydraulic gradients were present across the channel bottom material. The following table summarizes the results of the groundwater and surface water level measurements.

Measuring Point	Water Level Elev. (ft MSL)	Vertical Hydraulic Gradient
TP-1 (groundwater/surf. water)	448.75/448.56 - (08/20/96	upward
	448.79/448.66 - (10/30/96)	upward

Measuring Point	Water Level Elev. (ft MSL)	Vertical Hydraulic Gradient
TP-2 (groundwater/surf. water)	444.88/445.16 - (8/20/96)	downward
	445.00/445.15 - (10/30/96)	downward
TP-3 (groundwater/surf. water)	444.19/443.60 - (08/20/96)	upward
	443.98/443.58 - (10/30/96)	upward
SG-3	448.80 - (08/20/96)	not applicable
	448.85 - (10/30/96)	not applicable
HS9(s)	456.68- (08/20/96)	not applicable
	457.56 - (10/30/96)	not applicable
HS10(s)	451.62 - (08/20/96)	not applicable
	454.02 - (10/30/96)	not applicable
HS11(s)	449.29 - (08/20/96)	not applicable
	451.95 - (10/30/96)	not applicable
HS12(s)/HS13(i)	449.36/451.77 - (08/20/96)	upward
	451.59/454.08 - (10/30/96)	upward

Upward gradients were observed at temporary piezometers TP-1 (head differences of 0.19 and 0.13 ft.) and TP-3 (head differences of 0.59 and 0.40 ft.). In addition, the upward gradient previously observed at well nest location HS12(s)/HS13(i) was confirmed. At TP-2 a slight downward gradient (head difference of 0.28 ft.) was observed.

As described in Section 2.3.1, there was some difficulty in advancing TP-2 and the completed piezometer has approximately one foot of screened interval open to the channel bottom material. Given the installation methods utilized, it was not possible to verify the nature of the screened material at TP-2, nor the potential for the hydraulic head measurements to be representative of the underlying channel bottom material. For the purpose of the RI, it was assumed that the downward gradients measured on the two occasions were valid.

After three rounds of water level measurements from the wells and piezometers south of Marquette Street it is evident that with the exception of TP-2 the vertical hydraulic gradient within and across the Peat is upward. The beaver dams will produce a

localized, steeper surface water gradient from upstream of the beaver dams to downstream. The beaver dams may, therefore, produce a localized downward gradient upstream of the dam. Based on the regional hydrogeology, the South Ditch Area is a discharge zone, and therefore will exhibit generally upward gradients. If they are present, perturbations to this overall regime due to the presence of beaver dams will be minor and localized.

3.5 South Ditch Hydrology

The approved Focused South Ditch Remedial Investigation/Feasibility Study Work Plan did not include any provision for a hydrologic investigation of the South Ditch. Therefore, no quantitative investigation of the South Ditch hydrology was performed. However, the influence of the beaver dams on hydrology within the ditch can be discussed in a qualitative manner.

Beaver dams are located along the length of the South Ditch at six locations (Figure 2-1). The beaver dams form barriers to flow within the South Ditch. These barriers serve to slow the flow velocity and increase the residence time of water. The increase in residence time allows more time for chemical precipitation to occur along the length of the South Ditch. Decreases in flow velocity associated with the beaver dams also help minimize the potential for the unnatural sediment to be mobilized.

4.0 FATE AND TRANSPORT

The objective of this section is to describe the fate and transport of unnatural sediment-derived constituents in the Study Area. To accomplish this goal, it is necessary to describe the source of these constituents, the physical and chemical characteristics of the unnatural sediment which affect transport processes, and the pathways for migration of these constituents.

4.1 Source and Source Area

4.1.1 Unnatural Sediment Formation

As discussed in Section 1.3.1, flow within the South Ditch is derived from surface water directed along the North Ditch, discharge from the Center and South IRM wall underdrains, and groundwater springs and seeps. Each of the major components of flow (i.e., IRM wall discharge, surface water, and groundwater seeps and springs) which comprise the South Ditch discharge is characterized by a distinct geochemistry. The geochemistry of each of these flows has been quantified in part during this and previous studies. Table 4-1 presents a compilation of laboratory and field analytical results for samples collected from locations considered representative of the South Ditch and each of its component flows. Figure 4-1 shows the locations of these sampling points.

The data presented in Table 4-1 for the discharge from the Center and South IRM wall underdrains are averages of weekly analytical results between 1991 and May 1994. The analytical results shown for the NPDES discharge are a combination of data from a one-time sampling event at location SW-3 in the North Ditch (SAP, Table 9.14) and weekly data from Location III in the existing sump. It was necessary to combine data from the two sampling locations in order to represent each of the parameters shown in Table 4-1 for the NPDES discharge. The analytical results for groundwater and South Ditch surface water are from single sampling events completed on the indicated dates. Although these data were not collected from a series of simultaneous sampling events,

the evaluation of these data are useful in determining relationships between surface water flow and the chemical composition and formation of the unnatural sediment.

Table 4-1 indicates that the pH of groundwater from the Center and South IRM wall underdrains is in the range of 5.2 to 5.56. The pH of water from the NPDES drain was 7.35. The concentrations of many of the TPL metals (i.e., zinc, copper, cadmium, lead, iron, manganese and nickel) were higher in flow from the IRM walls than in the NPDES discharge. The higher metal concentrations are consistent with their greater solubility in the lower pH environment and the greater residence time that groundwater has had in the potential source material, as compared with surface water.

Mixing of flows from the IRM wall underdrains and the NPDES discharge produces a combined flow having an intermediate pH which is greater than that of the discharge from the IRM walls. This increase in pH acts to lower the solubility of metals contained within the combined flow and initiates their precipitation. As flow from the existing sump reaches the South Ditch, it is mixed further with groundwater seeps and springs having a pH on the order of 6.4. The combined effect of mixing flows from each of these sources is an average pH in the South Ditch of about 6.6. This increase in pH further reduces the solubility of the metals which prompts their precipitation. Specifically, the mixing of these two flows will result in dramatic reduction in the solubility of iron, which is very sensitive to incremental changes in pH in this range. This reduction in the solubility of iron creates iron hydroxide precipitates which easily adsorb other metals. Consequently, iron precipitation may cause the relatively rapid removal of other metals from the water along the length of the South Ditch.

Several additional factors serve to facilitate unnatural sediment formation in the South Ditch. Table 4-1 indicates that groundwater in the vicinity of the South Ditch is enriched with carbonate and possibly phosphate alkalinity relative to the other flow components. This suggests that groundwater serves as the source of carbonate and phosphate ions which bond with the zinc to form the primary unnatural sediment solids (i.e., smithsonite and zinc phosphate). Another factor influencing unnatural sediment formation is the six beaver dams distributed along the length of the South Ditch. The six

beaver dams act to lengthen the residence time of the contained flow as compared with an unrestricted channel. The relatively high residence time allows the flow components to mix completely, precipitation to occur, and equilibrium between the surface water and unnatural sediment to be approached or reached.

The results of the Focused RI indicate that metal concentrations in the unnatural sediment decrease along the length of the South Ditch while the pH of unnatural sediment increases. Between transect 1 and 3, the pH of the unnatural sediment was observed to decrease from 6.88 to 6.78 (after averaging values for duplicate samples). Between transects 3 and 11, the pH of the unnatural sediment increases from 6.78 to 7.89. The unnatural sediment pH at transect 13 was 7.74. Collectively, these observations suggest that unnatural sediment precipitation, prompted principally by changes in pH and carbonate and phosphate activity, occurs along the length of the South Ditch.

The unnatural sediment exists as a low density mixture of amorphous and crystalline chemical precipitates along with naturally derived, predominantly silicate and clay mineral sediment. The metals and metallic compounds/complexes in the amorphous and crystalline forms present in the South Ditch, constitute the source material.

4.1.2 Chemical Form and Mobility

The mineralogical testing indicates that the unnatural sediment is composed of chemically precipitated amorphous material and several mineral phases. In addition, it appears that a relatively minor quantity of natural material is associated with the unnatural sediment. However, the natural material constitutes a minor volume and is characterized by background concentrations of metals. It appears that the bulk of the unnatural sediment is composed of the amorphous chemical precipitates. The amorphous materials likely consist of iron and other metal hydroxides. Mineral phases identified in the remainder of the material consist of smithsonite ($ZnCO_3$), an unnamed hydrous zinc phosphate mineral ($Zn_3(PO_4)_2 \bullet 4H_2O$), and anhydrite/gypsum ($CaSO_4$)/($CaSO_4 \bullet 2H_2O$).

Little information is available on the chemical form of the amorphous material. Consequently, it is difficult to make predictions about its solubility, mobility, and fate based on existing research. However, the SPLP analyses conducted during the Focused RI provide information regarding the leachability of metals from the unnatural sediment. Using a 4.2 pH solution, cadmium, copper, manganese, and zinc were detected in each leach sample in the ppm range. However, the pH of the leach solution is not representative of the pH of water to which the unnatural sediment is exposed. The pH of groundwater in the vicinity of the South Ditch is 6.4 (Table 4-1). The pH of water discharging from the IWTP will be even higher. The average pH of South Ditch surface water is 6.6 (Table 4-1). Consequently, no information currently exists on the leachability of the unnatural sediment at these higher pH values. Nevertheless, it can be assumed that the metals concentrations in leachate derived from these higher pH solvents would be significantly lower than the SPLP results.

As discussed previously, the unnatural sediment has a gelatinous, cohesive consistency and is very fine grained. The percent fines in the unnatural sediment from the upper 2 feet of the column were between 67 and 76 (Table 3-2). Due in part to the six beaver dams distributed along its length, surface water flow velocities in the South Ditch are typically very low. Taken together, these factors greatly limit physical transport of the unnatural sediment by surface water under normal flow velocity conditions.

Figure 4-2 shows the stability diagram for zinc species as a function of Eh, pH, and partial pressure of CO_2 (pCO_2). It should be noted that this stability diagram does not incorporate any of the other major ions which may be important in unnatural sediment formation. As a result, the stability diagram in Figure 4-2 should be considered only a generalized schematic representation of the stability fields for the Site. These diagrams are useful for studying the phase relations for simple, few-component systems at low ionic strengths, under equilibrium conditions. At higher ionic strengths, these relationships break down due to the interaction between neighboring ions. Figure 4-2 shows that within the range of stability of water, the zinc phases are sensitive to changes in pH and pCO_2 and not Eh. The diagram also indicates that where $ZnCO_3$ (smithsonite) is stable, the pCO_2 value should be greater than about $10^{-3.2}$ or 0.0006 atm.

Atmospheric pCO_2 commonly ranges around $10^{-3.5}$ or 0.00035 atm. This suggests that the unnatural sediment is enriched with CO_2 relative to atmospheric CO_2 in order to precipitate smithsonite. Although aqueous CO_2 concentrations were not measured along the South Ditch, the groundwater data presented in Table 4-1 indicate relatively high alkalinity (most likely to be bicarbonate ion) in the vicinity of the South Ditch which would suggest that elevated CO_2 concentrations are likely.

Very little geochemical information is available for the hydrous zinc phosphate mineral, but it is assumed to behave similarly to other phosphate minerals, such as apatite. In the case of the zinc phosphate solid, the activity of phosphate and the pH of the water will affect its stability. Elevated levels of phosphate and mid-range pH values will promote the stability of the zinc phosphate solid.

The field measurements from the South Ditch surface water indicate a slightly reducing environment while the mineralogical data point to a slight oxidizing environment. Zinc has only one valence state within the stability field of water. As a consequence, Eh does not have a significant influence on the stability of either the smithsonite or the zinc phosphate solid found in the Study Area. However, other elements such as iron, sulfur, carbon, nitrogen, and manganese are dependent on the Eh of the environment due to multiple valence states within the stability field of water. Changes in the valence state of these elements could potentially affect the stability of the identified zinc phase. For example, if the reduced form of sulfur were to be stable at the Site, then zinc sulfides would likely form instead of zinc carbonates and phosphates.

The primary controls on zinc mobility along the South Ditch are the pH, pCO_2, and the activity of phosphate in both the surface and groundwater. Based on the observed conditions along the South Ditch (oxidizing, pH range 6.64 to 8.06, and elevated PO_4^{-2} and pCO_2), zinc will tend to form solid phases. Changes in any of these conditions could potentially remobilize zinc currently locked up in the unnatural sediment. However, it should be noted that the pH changes necessary to mobilize the zinc minerals are significant. Furthermore, even at significantly lower pHs, the metals contained within the solid phases are not highly mobile as evidenced by the SPLP results.

Additional controls on the mobility of cations are the formation of colloids and amorphous solids along with cation exchange involving clays. Little data exist on these phases, but they potentially represent important factors in the mobility of elements such as iron, copper, and cadmium. To a lesser extent zinc will also be affected by the formation of colloids and amorphous solids. These phases commonly form hydrous or hydroxide compounds. Amorphous solids potentially can form minerals in the unnatural sediment, given the correct environment.

Cation exchange could potentially be an important process along the South Ditch. This is due to an abundance of clays in the unnatural sediment. The most abundant natural minerals identified by the XRD study were illite and quartz. The cation exchange capacity (CEC) results indicate an increase in values along the tested length of the South Ditch from 5.2 meq/100gms at sample 7A to 23 meq/100gms and 13 meq/100gms at samples 13A and 13B, respectively. This likely reflects the increase in the lacustrine material content of the unnatural sediment toward the distal end of the South Ditch as discussed in Section 3.2.6. Typical values of CEC for a quartz sand are on the order of 1 meq/100gms (Lyon and Patterson, 1984) Typical CEC values for illite are between 10 and 40 meq/100gms (Drever, 1982). The CEC values for the distal end of the South Ditch lie within the typical range of values for illite. Consequently, the fraction of illite within the unnatural sediment serves to retain metal cations and resist their exchange with South Ditch surface water.

4.3 Migration Pathways

The potential pathways for migration of unnatural sediment-derived constituents include: groundwater, surface water, and air. These potential pathways are discussed in the following sections.

4.3.1 Groundwater

Groundwater is not a likely pathway for unnatural sediment constituents at the Study Area for the following reasons. In general, groundwater may transport suspended particles and dissolved species. However, in a fine grained porous medium, surface filtration, straining, adsorption, and flocculation act to limit the effectiveness of groundwater transport of suspended chemical constituents. Groundwater transports dissolved species through advection and diffusion. The potential for unnatural sediment constituents to re-enter the dissolved phase was discussed in Section 4.1. Section 4.1 concluded that the unnatural sediment is stable and that significant changes in the pCO_2 or pH conditions would be necessary for unnatural sediment dissolution to occur. In either case, the potential for groundwater to act as a pathway would require unnatural sediment dissolution and significant changes to the present chemical environment.

The direction and rate of groundwater movement are important factors in determining whether groundwater is a pathway. As part of this study, piezometers were installed through the base of the South Ditch in order to measure groundwater potentials in the channel bottom material. By comparing the head in this material with the surface water elevations in the South Ditch, the direction and magnitude of the vertical gradient, if any, could be determined. Evaluation of regional and site hydrogeologic data from the Focused RI (see Section 3.4) and the South Ditch Corridor Hydrogeologic Study (Golder, 1995) suggests that upward vertical gradients exist between the alluvial aquifer and surface water. This upward vertical gradient would result in upward groundwater flow from the alluvial aquifer, through the Peat underlying much of the South Ditch, and into the South Ditch and adjacent Lake DePue. This upward flow direction effectively eliminates the potential for groundwater to be a migration pathway.

4.3.2 Air

Air is not a likely pathway for unnatural sediment constituents in the Study Area for the following reasons. Since the unnatural sediment constituents are inorganic and non-volatile, concern regarding this pathway is focused on dust transport. The potential for

dust transport from the South Ditch is controlled by two factors: the flow conditions within the South Ditch, and the moisture content of the unnatural sediment.

Observations by Site personnel indicate that even during periods of drought, flow occurs within the South Ditch. Therefore, the unnatural sediment present within the channel of the South Ditch is covered with water throughout the year and is not subject to mobilization by air.

The unnatural sediment present along or above the wetted perimeter of the drainageway is generally subaerially exposed. However, this unnatural sediment presents little potential for dust generation. As discussed in Section 3.1, the water content of the unnatural sediment is on the order of 75%. Although the water content was determined for the unnatural sediment sampled from the base of the drainageway, water content for subaerially exposed unnatural sediment is likely comparable. Comparable water contents are expected since water is a chemical constituent of the unnatural sediment as discussed in Section 4.2. The assertion that the unnatural sediment along the South Ditch generally remains wet is supported by empirical evidence. During inspections of the South Ditch at various periods throughout the year, the unnatural sediment has been observed to be wet and extremely soft. Therefore, in summary, the air pathway is not considered a pathway of concern.

4.3.3 Surface Water

Surface water is a potential pathway for unnatural sediment constituents in the South Ditch. Surface water is considered a potential pathway because it is in direct contact with the unnatural sediment and may transport constituents mechanically and/or chemically.

The potential for mechanical transport of the unnatural sediment is largely controlled by the flow rate within the South Ditch. Under normal flow conditions, mechanical transport of the unnatural sediment is limited by the presence of the six beaver dams located along the length of the ditch. The beaver dams act to limit unnatural sediment

movement in two ways. First, the dams retard flow velocities and consequently, the size of the unnatural sediment entrained by the flowing water. Second, the dams catch unnatural sediment already entrained within the discharge. Therefore, under normal conditions, mechanical transport of the unnatural sediment is not expected to be significant. However, under high flows, the beaver dams may be damaged or the channel may establish a new course. Under these conditions, unnatural sediment redistribution may occur within the South Ditch.

On an annual basis the Study Area is inundated due to flooding of the Illinois River and DePue Lake. During these flood events, portions of the Study Area will be submerged and flow within the lower portions of the South Ditch will be altered. The flooding will tend to eliminate the discrete flow within the submerged part of the South Ditch channel. Although flooding occurs on a regular basis, the flood events result in gradual fluctuations in water level and do not appear to have altered the South Ditch channel or substantially eroded the beaver dams. Based on observations during flood events, it appears that erosion potential, channel re-establishment, and redistribution of existing unnatural sediment is minimal. During flooding in the lower reaches of the Study Area, it is possible that the suspended material within the South Ditch flow may be transported beyond the limits of the Study Area.

Chemical transport of unnatural sediment constituents within surface water is also a potential migration pathway. Under this scenario, unnatural sediment dissolution and advective transport would occur by surface water. This pathway is largely controlled by the unnatural sediment form and mobility, discussed in Section 4.2, and the surface water quality.

Metals precipitation in the South Ditch results primarily from increases in the pH of surface water which occurs in response to mixing water from the IRM wall underdrains with water from the NPDES discharge and groundwater springs and seeps. In response to this mixing, and additional mixing with groundwater, the pH of surface water has been shown in previous investigations to increase along the length of the South Ditch. This pH increase lowers the solubility of the metals and consequently they precipitate,

forming the unnatural sediment. Unnatural sediment dissolution and metals transport would constitute a reverse in the chemical processes currently occurring in the South Ditch. In order for this to occur, the direction of pH change along the South Ditch would have to reverse resulting in a decrease of between one and two standard units. No natural mechanisms exist for triggering such a dramatic change in the geochemistry of the South Ditch. Additional data is necessary to facilitate the assessment of the fate of metals in the unnatural sediment.

5.0 QUALITATIVE RISK ASSESSMENT

5.1 Introduction

This section presents a qualitative assessment of the potential risk that the unnatural sediment poses to human health and to indigenous flora and fauna inhabiting the Study Area. This qualitative risk assessment has been prepared in accordance with the Work Plan. This qualitative risk assessment is limited in scope and is not intended to take the place of the full quantitative Site-Wide risk assessment, but is designed only to determine whether the unnatural sediment within the Study Area requires remedial action. According to the NCP, in situations where prompt early action may be indicated, "[q]ualitative risk information should be organized that demonstrates that the action is necessary to stabilize the site, prevent further degradation, or achieve significant risk reduction" (Section 300.430(a)(1)(ii)). It is anticipated that the comprehensive baseline risk assessment to be conducted in the Site-Wide RI/FS will include a re-evaluation of the Study Area.

5.2 Ecological Risk Assessment

The ecological risk assessment (ERA) utilized analytical results from the unnatural sediment to establish potential chemicals of interest. The assessment then employed a screening appraisal to determine whether detected concentrations exceed acute risk levels for these metals.

5.2.1 Exposure Pathways

Exposure of ecological receptors to constituents of potential interest within the Study Area could be through direct exposure of biota to affected water, direct exposure to the unnatural sediment, or indirect exposure by ingestion of prey carrying unnatural sediment constituents. Under current conditions, exposure to water from the South Ditch could be a potential pathway; however, the construction of an IWTP by the DePue Group will significantly reduce water-borne metals loading to the South Ditch.

Therefore, for the purpose of the Focused RI/FS, and this ERA, exposure of biota is expected to be through contact with and ingestion of the unnatural sediment, or by ingestion of unnatural sediment-dwelling biota.

5.2.2 Ecological Receptors

There appears to be only limited accounts of biota that inhabit the Lake DePue area, and species specific accounts for the Study Area are practically non-existent. The following list of potential ecological receptors is based on a brief review of several sources.

Mammals

Chapman (1994) noted beavers (*Castor canadensis*) inhabiting the South Ditch; and, the location of several beaver dams on the South Ditch was used to define the limits of the Study Area. There is no information on other mammalian species inhabiting the Study Area.

Birds, Reptiles, and Amphibians

There is no information specifically detailing the presence of avian, reptilian, or amphibian species utilizing the South Ditch. Kleen (1993, cited in Young 1995) noted the presence of a great blue heron (*Ardea herodias*) and great egret (*Casmerodius albus*) rookery at the nearby Lake DePue State Fish and Wildlife Refuge; however, there is no indication that these species use the Study Area. Similarly, several species of waterfowl, including wood duck (*Aix sponsa*), mallard (*Anas platyrhinchos*), and Canada goose (*Branta canadensis*) are known to nest in the Lake DePue area; however, there is no information on nesting by these species in the Study Area, nor is there record of these species using the South Ditch for feeding, nesting, or other purposes.

Fish

Crappie (species not given), carp (*Cyprinus carpio*), bigmouth buffalo (*Ictiobus cyprinellus*), catfish (species not given), bass (species not given), gizzard shad (*Dorosoma cepedianum*), and bluegill (*Lepomis macrochirus*) are reported residents of the Lake DePue ecosystem.

However, there is no information on the extent that the South Ditch is used by these or other fish species.

Invertebrates

Except for a reference by Young (1995) that ephemeropterans (*Hexagenia* sp.) are locally abundant in Lake DePue, there is no information on the diversity and abundance of the benthic invertebrate community in the South Ditch and Lake DePue ecosystems. Similarly, there is no information on zooplankton or other invertebrate communities.

Plants

Terra (1995) noted that vegetation in the South Ditch was sparse, mainly consisting of unknown species of algae. No mention was made of aquatic macrophytes in the South Ditch.

5.2.3 Discussion of Results

Results of 4 day exposures of midge larvae (*Chironomus tentans*) and amphipods (*Hyalella Azteca*) to laboratory control sediment, Turner Lake sediment, and the unnatural sediment are shown in Tables 3-8 and 3-9. As discussed in Section 3.2.7, the unnatural sediment within the South Ditch demonstrated an acute effect as measured by the total mortality of the midge larvae and amphipods.

The present study measured TPL metals in the unnatural sediment collected at a number of different transects and depths. This ERA is focused only on the surface unnatural sediment (top 6 inches) that South Ditch biota have the highest probability of contacting or ingesting. Ontario and British Columbia Provincial Guidelines for aquatic sediment quality (Persaud et al., 1992; Nagpal, 1995) can be utilized to provide Severe Effect Level (SEL) and Lowest Effect Level (LEL) for Ag, As, Cd, Cr, Co, Cu, Hg, Mn, Ni, Pb, and Zn. Nagpal (1995) provided Interim Guidelines for Se. No sediment quality guidelines are available for Be and V. Sediment quality guidelines are useful for judging the potential for ecological effects; however, one should use caution in interpreting these guidelines because there are many site-specific factors that may modify the toxicity of constituents

to indigenous organisms (US EPA, 1992). Furthermore, the sole use of these guidelines in the absence of site-specific toxicity and sediment characterization data can lead to an incorrect estimate of ecological risk. This is because general guidelines are designed to be conservative.

Levels of Cd, Cu, Pb, and Zn were markedly elevated (20 to 250 times reference levels) in the unnatural sediment, relative to the Turner Lake sediment; while levels of Ag, As, Be, Co, Hg, and Mn were slightly to moderately (2 to 10 times) elevated. Ni, Se, and V were present at similar levels in the Turner Lake sediment and the unnatural sediment. Cr was generally present at higher levels in Turner Lake samples than in South Ditch samples, except for unnatural sediment samples SD-013A-000 and SD-011-000 (less than two times reference samples).

Levels of Ag, Cd, Cu, Hg, Mn, Ni, Pb, and Zn exceed the LELs (Table 5-1) of the available sediment quality guidelines, indicating that these metals may have at least some effect on sediment dwelling organisms. Levels of Cd, Cu, Ni, Pb, and Zn also exceed the SEL thresholds for sediment (Table 5-1), indicating that these metals may have more significant impacts on biota in the South Ditch unnatural sediment.

In the Turner Lake samples, levels of Ag, As, Cd, Cu, Hg, Mn, Ni, Pb, and Zn overlap or exceed the lowest effect thresholds for sediment quality; while levels of two metals, Cd and Pb, overlap the SEL threshold (Table 5-1). Comparison with guidelines is subject to the same caveat as given above; i.e., guidelines are conservative and do not necessarily predict actual risk at a specific site.

Exceedance of the sediment quality guidelines may not predict actual risk at a site. However, for South Ditch unnatural sediment the results of the acute toxicity testing support using the guidelines to identify the need for expedited response actions.

5.2.4 Characterization of Risk to Ecological Receptors

A conceptual model of source, constituents of concern, transport mechanisms, and ecological receptors in the Study Area was developed. For the purpose of the model, the main transport medium for these metals is assumed to be the unnatural sediment. Although the water column itself is presently an important transport medium for some constituents, it is expected that this situation will be changed once the IWTP has been completed.

The predominant constituents in the South Ditch are metals, particularly Cd, Cu, Pb, and Zn. Factors such as the presence of AVS may influence the bioavailability of metals; however, in the case of the unnatural sediment, it appears that metals levels are sufficiently elevated that modifying factors are not a factor in reducing toxicity.

Potential ecological receptors in the South Ditch are plants (including algae and macrophytes), invertebrates (including zooplankton and benthos), fish, piscivorous and insectivorous birds, and beavers. Beavers are the only one of these potential receptors for which confirmed sightings have been made in the South Ditch, all others are only assumed to use the South Ditch area, and may or may not enter the South Ditch area periodically.

There is no evidence of bioaccumulation of metals in Lake DePue fish, and no evidence of bioaccumulation of metals in piscivorous birds (Chapman, 1994). The continued observation of beavers in the South Ditch suggests that this species is not acutely affected.

5.2.5 Conclusions

The acute toxicity tests conducted show that the unnatural sediment is toxic to midge larvae and amphipods. The qualitative comparison of maximum constituent concentrations with sediment criteria show that elevated metal concentrations exist in the South Ditch unnatural sediment and those elevated concentrations probably cause a severe effect on benthic organisms in the South Ditch unnatural sediment. The results of

this ERA indicate that the unnatural sediment may pose a threat to benthic invertebrates that may inhabit the South Ditch.

5.3 Human Health Risk Assessment

The objective of this risk assessment is to determine the need for expedited remedial action at the South Ditch due to the possibility of an imminent human health threat from the unnatural sediment. Generic soil or sediment screening values specifically developed to support decision making regarding the need for expedited remedial actions do not currently exist. This assessment uses the Tiered Approach to Corrective Action Objectives (TACAO) (IEPA, 1996) as the source of screening values.

Consistent with the TACAO recommendations, this assessment uses elements of site-specific risk assessment but applies them in straightforward ways that should aid in determining the need for an expedited remedial action.

For the purpose of this assessment, two sets of screening values are used: one to represent a child trespasser scenario and another to represent a construction worker scenario. These two scenarios represent possible current and/or future land uses for the Study Area. Protection of a child trespasser and construction worker from an imminent human health threat is expected to ensure adequate protection of other potential human exposures. However, selection of these receptors for this screening risk assessment does not imply that these same receptors will necessarily be evaluated in an assessment of potential health effects from long-term exposures. Such a determination is reserved for the comprehensive baseline risk assessment to be conducted in the Site-Wide RI/FS.

The two exposure pathways of interest for this risk assessment are incidental soil ingestion and fugitive dust inhalation. Dermal exposure is generally not an important exposure pathway for metals in soil because of the low degree of absorption across the skin under these circumstances.

The groundwater ingestion route is not evaluated in this assessment because this pathway is not relevant to the South Ditch. The South Ditch Hydrogeologic Study (Golder, 1995) showed that constituents in the South Ditch were not affecting the alluvial aquifer. The presence of the Peat and upward vertical hydraulic gradients significantly limit the potential for transport of constituents from the unnatural sediment to groundwater. In addition, the most recent well survey, conducted in 1990, shows that the source of municipal water in DePue is a deep bedrock aquifer (Public Health Assessment, 1993) and that the only private wells currently in use are located upgradient of the Study Area. In accordance with the ICO, the DePue Group will update the well survey. However, unless the updated well survey indicates otherwise, groundwater does not appear to be a pathway of concern for unnatural sediment constituents.

5.3.1 Development of Screening Values

5.3.1.1 Child Trespasser Scenario

The child trespasser scenario is characterized by a child ages 6 to 12 who uses the South Ditch area for recreational purposes. This is a possible scenario because the nearest homes to the South Ditch are about 300 feet away (to the northwest), and fences currently in place incompletely surround the South Ditch.

The screening values used for the child trespasser scenario were calculated using TACAO Tier 2 soil screening level equations using default and scenario-specific exposure parameter values. Equations S1 and S2 were used to calculate screening concentrations for soil ingestion of noncarcinogenic and carcinogenic constituents, respectively. Equations S11 and S13 were used to calculate screening concentrations for fugitive dust inhalation of noncarcinogenic and carcinogenic constituents, respectively. The exposure parameter values used in these equation are provided in Table 5-2.

Although the child is assumed to be in the South Ditch for 50 days per year, the exposure frequency for the inhalation pathway is 8.3 days. An adjustment to the exposure frequency is made to account for the assumption that the child is present for only 4

hours on each of the 50 days. In other words, the child is present on-site for 200 hours per year, which is equivalent to 8.3 whole days. A similar adjustment is not made for the soil ingestion pathway because it is conservatively assumed that the child gets his/her entire daily soil exposure during each of the 50 visits to the Study Area.

Although the exposure duration is assumed to be 50 d/yr for the child trespasser scenario, child exposure to the unnatural sediment requires that the unnatural sediment be dry, especially for the dust inhalation pathway. When moist or covered by water, as is usually the case, the unnatural sediment is not a source of dust. It is only under unusually dry conditions that wind erosion may release the unnatural sediment into the air. Consequently, assuming that an inhalation pathway exists for the 50 days that the child is assumed to visit the South Ditch is likely to be an overestimate.

TACAO Equations S11 and S13 do not include inhalation rate and body weight as parameters. The values characterizing these parameters are selected by EPA, and are incorporated in the inhalation toxicity values (reference concentrations and unit risks). It is important to examine whether the default values selected by EPA adequately characterize the child receptor for the trespasser scenario. In developing the inhalation toxicity values for the chemicals being evaluated for this assessment, EPA assumes a body weight of 70 kg and an inhalation rate of 20 m^3/d.

The default inhalation rate of 20 m^3/d, which is equal to 0.83 m^3/hr, is adequate for characterizing the inhalation rate of children who might play in the South Ditch. Inhalation rate is dependent upon a person's level of activity. The activity level of children at play may range from sedentary (quiet play in one location) and light (slow walking) to heavy (running or other very active play). The ditch itself is not inviting as a play area. Ingress and egress for the northernmost portion of the South Ditch is made difficult by steep, unstable slopes. The remainder of the South Ditch is located within a marshy lowland adjacent to DePue Lake, and is often covered with water. The lack of flat, solid ground suggests that the South Ditch is more conducive to sedentary and light play rather than active play.

US EPA (Draft Exposure Factors Handbook, 1995) recommends a default value of 0.4 m^3/hr for children ages 1-12 during sedentary activity, 1.0 m^3/hr for light activity, 1.2 m^3/hr for moderate activity, and 1.9 m^3/hr for heavy activity. The default inhalation rate of 0.83 m^3/hr is consistent with the sedentary and light activity that would be expected for children playing in the South Ditch. Consequently, no adjustment is necessary with respect to the default inhalation rate selected by US EPA.

The default body weight selected by US EPA (70 kg) is a factor of 2.2 higher than the body weight used in this assessment to characterize the child receptors (32 kg). In order to ensure that the risk-based screening values are appropriate for the child receptors, these values must therefore be adjusted downward by a factor of 2.2.

The toxicity values used to calculate the screening values were obtained from the most recent versions of US EPA's Integrated Risk Information System (IRIS; an on-line database accessed on January 6, 1997), Health Effects Assessment Summary Tables (HEAST; US EPA, 1995), or other appropriate US EPA documents. Subchronic toxicity information was judged most appropriate for developing the screening values used to evaluate the child trespasser scenario. Chronic toxicity data was used if subchronic toxicity information was not available. It should be noted that in many cases where US EPA provides subchronic toxicity values, they do not differ from the chronic toxicity value. Table 5-3 lists the US EPA toxicity values and their sources used to calculate screening values for the child trespasser scenario.

The child trespasser screening values calculated by using the equations and parameter values described above are presented in Table 5-4.

5.3.1.2 Construction Worker Scenario

The construction worker scenario is characterized by short term direct contact with soil by workers. The screening values used for the construction worker scenario are the TACAO Tier 1 soil remediation objectives for construction. These screening values are presented in Table 5-5.

5.3.2 Comparison of South Ditch Concentrations to Screening Values

Tables 5-4 and 5-5 shows the screening values for the child trespasser and construction worker scenarios, respectively. These screening values are compared with maximum unnatural sediment concentrations for the South Ditch. Because the focus of this assessment is to evaluate the need for an expedited remedial action, data for this assessment are handled as follows:

- all data were used to determine the maximum concentration, regardless of their associated data qualifiers or sample depth. None of the laboratory data qualifiers provided sufficient justification to reject the data and all data were judged suitable for use in the risk assessment; and
- maximum values (rather than averages or upper confidence limits) are used to characterize constituent concentrations.

Although this approach is more conservative than may be necessary to protect people from imminent health effects, such simplifications help to expedite the screening process. Such an approach is not appropriate for evaluating chronic exposures or establishing cleanup levels.

Unnatural sediment concentrations in Tables 5-4 and 5-5 are presented for two depth ranges. The second column presents maximum concentrations for TPL metals detected from zero to six inches in depth within the Study Area, while the third column shows maximum concentrations for all unnatural sediment samples analyzed for TPL metals at all depths. Of the two data sets, samples collected from zero to six inches are more representative of concentrations to which people may be exposed. However, for the purpose of this assessment, the maximum concentration for all samples, regardless of depth, is used for comparison to screening values.

5.3.2.1 Comparison to Child Trespasser Screening Values

As indicated by shading in Table 5-4, maximum concentrations of arsenic, copper, and lead in the unnatural sediment exceed the screening values calculated for the child trespasser scenario. None of the constituent concentrations exceed the screening values

for the inhalation pathway for those constituents with numerical inhalation toxicity values. No screening values are calculated for the inhalation pathway for cobalt, copper, lead, selenium, silver, vanadium, and zinc due to a lack of inhalation toxicity values. However, a qualitative understanding of the potential inhalation toxicity of these compounds in the environment does not suggest that they would be more toxic by inhalation than by ingestion (for which screening values are provided).

In comparing the maximum constituent concentrations and screening values (for soil ingestion), arsenic exceeds its associated screening value by less than a factor of 2. This screening value is based on arsenic's carcinogenic potential, not its systemic toxic effects. This screening is based on a target cancer risk value of 10^{-6} which is the target cancer risk in TACAO (Appendix C, Table B). A screening value based on toxic effects other than cancer is 350 mg/kg for arsenic, over four times higher than the maximum detected arsenic concentration.

The maximum concentration of copper exceeds its respective screening value by a factor of approximately 2. In its recommendation for an interim reference dose for copper, EPA (1991) recommends a value between 0.04 and 0.07 mg/kg-d. Copper is an essential nutrient, and copper intake for adults should be at least 0.02 to 0.04 mg/kg-d (EPA, 1991). A reference dose of 0.04 mg/kg-d is, therefore, lower than necessary to protect against copper toxicity.

The 0.07 mg/kg-d reference dose is based on a report of poisoning involving copper in a cocktail which identified the lowest acute oral dose at which gastrointestinal effects (nausea, diarrhea, vomiting) were seen. In contrast, the World Health Organization has reported that a copper intake of 0.5 mg/kg-d would not cause adverse health effects (EPA, 1991). Based on this information, a reference dose for copper could reasonably lie in the range of 0.07 to 0.5 mg/kg-d. By comparing these values to the 0.04 mg/kg-d reference dose being used, a screening value based on copper toxicity may be larger by a factor of 2 or more. Consequently, the maximum detected concentration would be approximately equal to or less than the screening value.

The maximum lead concentration exceeds its respective screening values by a factor of approximately 10. The screening value for lead (400 mg/kg) is actually an US EPA preliminary remediation value based on residential exposures, and is more stringent than necessary to protect human health under chronic recreational scenarios.

The screening values developed for the child trespasser scenario incorporate some assumptions that make them appropriate for evaluating short term exposures. However, exceedance of a screening value does not necessarily indicate that a constituent poses an imminent health threat. Such an interpretation is justified for the following reasons:

- Screening values are compared to maximum detected concentrations. Actual chemical concentrations to which people may be exposed are likely to be smaller. The use of maximum detected concentrations inserts a protective bias into the screening process.

- For carcinogens, the degree of health protection (i.e., a target cancer risk of 1x10-6) is a policy decision that represents acceptable risk associated with long term exposures, such as may occur following final remedy selection. In contrast, this assessment addresses the issue of conducting an expedited, interim response, for which a less stringent criterion may be appropriate.

- Arsenic (the only carcinogen that exceeds a screening level) is associated with skin cancer following ingestion of soluble arsenic in drinking water. Although there are several studies that report skin cancer in people exposed for less than a year, in most cases skin cancer develops only after prolonged exposure (ATSDR, 1991). This raises the question as to whether arsenic as a carcinogen can pose a health threat via short term exposures. In addition, the South Ditch assessment is concerned with arsenic bound in soil, which is likely to be less bioavailable than the arsenic in drinking water which serves as the basis for the cancer slope factor.

- Noncarcinogens typically have built-in safety factors or other biases that result in screening values that are more protective than necessary for the purpose of this assessment. For example, the copper and zinc screening values are more appropriate for soluble forms ingested in water than copper and zinc bound in soil, which is likely to be less bioavailable. The lead screening value is based on protection of a small child age 0 to 84 months, (US EPA 1994) not the 6 to 12 year old age range under consideration.

- This assessment assumes that the unnatural sediment will be accessible for the 50 days per year that the child receptor is assumed to trespass onto the site. However, much of the South Ditch is either under water or in a marshy area for most of the

year, making unnatural sediment exposure unlikely. The long, unstable slopes and lack of a flat area suggests that the northern portion of the South Ditch is also an unlikely play area. Consequently, an exposure duration of 50 d/yr is expected to be protectively biased, resulting in screening values that are more protective than necessary.

Because of these inherent biases, the screening values should not be interpreted as "bright lines" that indicate the potential for an imminent health threat. Instead, exceedance of a screening level requires that the degree of exceedance be examined in light of the biases described above. For the child trespasser scenario, the exceedance of screening values is sufficiently small to support a conclusion that there is no imminent health threat.

Additionally, although an exceedance indicates the possibility of adverse health effects under long-term exposure conditions, no conclusions should be made regarding the potential for health effects under actual current or likely future exposure conditions. Such a determination is reserved for the comprehensive baseline risk assessment to be conducted during the Site-Wide RI/FS.

5.3.2.2 Comparison to Construction Worker Screening Values

As indicated by shading in Table 5-5, maximum concentrations of arsenic, cadmium, copper, lead, and zinc in the unnatural sediment exceed the screening values for the construction worker scenario. None of the constituent concentrations exceed the screening values for the inhalation pathway for those constituents with numerical inhalation toxicity values. No screening values are calculated for the inhalation pathway for cobalt, copper, lead, selenium, silver, vanadium, and zinc due to a lack of inhalation toxicity values. However, a qualitative understanding of the potential inhalation toxicity of these compounds in the environment does not suggest that they would be more toxic by inhalation than by ingestion (for which screening values are provided).

In comparing the maximum constituent concentrations and screening values (for soil ingestion), the arsenic concentration is slightly greater than its respective screening value, which in this case is based on toxic effects and not carcinogenic effects. Only 2 of the 49 samples had arsenic concentrations that exceeded the screening value.

The maximum detected cadmium and zinc concentrations both exceeded their respective screening values by factor of between 3 and 5. Exceedances were noted in approximately half of the unnatural sediment samples.

The maximum detected copper concentration exceeds its associated screening value by a factor of 12. As noted previously, the screening value for copper is based on a copper intake level that protects against the adverse health effects associated with copper deficiency (not toxicity). A screening value based on copper toxicity would be larger by at least a factor of 2 (US EPA, 1991).

As with the child trespasser scenario, the maximum lead concentration exceeds its respective screening values by a factor of approximately 10. The screening value for lead (400 mg/kg) is actually an US EPA preliminary remediation value based on residential exposures, and is more stringent than necessary to protect human health under the construction worker scenario.

As with the child trespasser scenario, the screening values developed for the construction worker scenario incorporate some assumptions that make them appropriate for evaluating short term exposures. However, exceedance of a screening value does not necessarily indicate that a constituent poses an imminent health threat. In addition to the reasons described in the Section 5.2.3.1, the construction worker scenario is a controlled setting in which certain work practices can be prescribed to limit or eliminate exposure. For the construction worker scenario, the exceedances of screening values are sufficiently small to support a conclusion that there is no imminent health threat.

5.3.3 Conclusions

Maximum concentrations of three constituents (arsenic, copper, and lead) exceed their respective screening values for the child trespasser scenario. Two additional constituents (cadmium and zinc) exceed their respective screening values for the construction worker scenario.

As described in Sections 5.2.3.1 and 5.2.3.2, this analysis indicates that, in spite of these exceedances, the constituents in the unnatural sediment do not pose an imminent human health threat and that an expedited remedial action to protect human health is not warranted. The screening values are exceeded only by small margins and/or the screening values are more stringent than necessary to protect human health under short term exposures.

This assessment suggests the possibility of adverse health effects under long term exposure conditions. However, such a determination is reserved for the comprehensive baseline risk assessment to be conducted in the Site-Wide RI/FS.

6.0 FINDINGS

The work scope was structured to characterize the horizontal and vertical extent of the unnatural sediment within the Study Area. The study included a qualitative risk assessment to determine whether the unnatural sediment presents an acute human health or ecological risk.

The following is a summary of the findings of the Focused RI:

- The entire Study Area is located within the 100-year floodplain.
- Approximately 7,900 cubic yards of unnatural sediment are present in the South Ditch. Depth probing along fourteen transects spaced along the length of the ditch indicate that the unnatural sediment is present in a layer that extends the entire length of the ditch. The layer is typically thickest along the middle of the channel, and the maximum thickness ranges between approximately three-and-one-half feet and seven feet.
- The texture of the unnatural sediment layer generally varies from a floc-like precipitate near the top to a very fine- to fine-grained material below. Laboratory testing also indicates that the unnatural sediment has between 67 and 76 percent fines, and no fraction coarser than medium sand. Laboratory testing of three samples indicate that the unnatural sediment has a solids content ranging from 24 to 27 percent, indicating that the unnatural sediment has a very high water content.
- Laboratory testing of the unnatural sediment for general chemistry parameters indicate that relative to background sediment samples from Lake Turner, the unnatural sediment has, in general, higher concentrations of iron, calcium, potassium, barium, silicon, sulfate, total organic carbon, alkalinity and N-ammonia. Laboratory testing of channel bottom samples indicates that, in general, the channel bottom material has elevated concentrations of sulfate relative to the background sediment concentrations. Additionally, the concentrations of iron, barium and sodium may be elevated in the channel bottom material relative to the background sediment concentrations.
- Laboratory testing of TPL metals in the unnatural sediment indicates that, relative to the background sediment samples from Lake Turner, the unnatural sediment contains higher concentrations of arsenic, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, selenium, silver and zinc. The most abundant TPL metals included zinc (concentrations up to nearly 20 percent), copper (up to approximately 10 percent), lead and manganese (each up to 0.3%), and cadmium (up to 0.1%). Overall concentrations of zinc, copper, lead and cadmium generally decline along the length of the ditch, and with depth. Although the channel

bottom material shows some effects from the unnatural sediment, it is evident that the concentrations of TPL metals is lower than detected in the unnatural sediment, suggesting that vertical attenuation has occurred.

- The SPLP testing indicates that lab-produced leachate from the unnatural sediment has very low metal concentrations relative to the unnatural sediment, and that the metals are not easily leached by the SPLP procedure. Given the observed pH conditions of the unnatural sediment it is unlikely that metals would leach from the unnatural sediment under typical conditions observed at the Site.

- The mineralogical testing indicates that the unnatural sediment is composed of chemically precipitated amorphous material and several mineral phases. In addition, it appears that a relatively minor quantity of natural material is associated with the unnatural sediment. However, the natural material constitutes a minor volume and is characterized by background concentrations of metals. It appears that the bulk of the unnatural sediment is composed of the amorphous chemical precipitates. The amorphous materials likely consist of iron and other metal hydroxides. Mineral phases identified in the remainder of the material consist of smithsonite ($ZnCO_3$), an unnamed hydrous zinc phosphate mineral ($Zn_3(PO_4)_2 \bullet 4H_2O$), and anhydrite/gypsum ($CaSO_4$)/($CaSO_4 \bullet 2H_2O$).

- The chemical precipitates formed as a result of the mixing of the relatively high-pH flows from the NPDES discharge and groundwater seeps and springs with the relatively low-pH IRM flow. This mixing caused formation of metal carbonates and hydroxides which precipitated along the length of the South Ditch. The mechanical transport of the unnatural sediment is presently controlled by six beaver dams located in the South Ditch. The dams retain existing material , trap additional unnatural sediment carried into the ditch by stream load, and allow the formation of additional chemical precipitates.

- Ecological testing indicates that, relative to laboratory control and Turner Lake background sediment, the unnatural sediment is acutely toxic to the two tested organisms.

- A qualitative ERA was conducted as part of the Focused RI. The results of the ERA indicate that the unnatural sediment may pose a threat to benthic invertebrates that may inhabit the South Ditch and are considered surrogates for other aquatic organisms in the South Ditch. In addition, metal concentrations in the unnatural sediment exceed sediment quality guidelines indicating the possibility of adverse effects. Beavers, however, have been noted in the South Ditch area; their presence indicates they are not acutely affected by the unnatural sediment.

- A qualitative human health risk assessment indicates that, under potential child trespasser and construction worker exposure scenarios, the unnatural sediment does not pose an imminent human health risk.

7.0 PROPOSED EXPEDITED REMEDIAL ACTION OBJECTIVES

The Focused RI identified elevated metal concentrations in the unnatural sediment located in the South Ditch. The qualitative risk assessment was intended to address potential risk to human health and ecological receptors from acute exposure. It was determined that the unnatural sediment contains metals at levels that may be acutely toxic to some potential ecological receptors but do not pose a human health risk.

Additional data is necessary to facilitate assessment of the fate of metals in the unnatural sediment. Additional studies should be performed to evaluate the leachability of metals from the unnatural sediment under conditions more representative of the environmental conditions currently existing, and expected to exist upon completion of the IWTP, in the Study Area.

The following expedited remedial action objectives are appropriate for the unnatural sediment:

- Mitigate the potential for flood water to mobilize the unnatural sediment.
- Mitigate the potential acute exposure risk to sensitive ecological receptors via direct contact with the unnatural sediment.
- Mitigate formation of additional chemical precipitates in the future.
- Mitigate the potential for water discharges to the South Ditch to mobilize the unnatural sediment.

As part of the ICO, the DePue Group is constructing an IWTP to remove metals from the surface water discharge to mitigate the continued formation of chemical precipitates. The IWTP is expected to be in operation by May 1997.

The following general expedited response actions are potential methods to address the objectives.

- Remove the unnatural sediment from the South Ditch and dispose of it in an on-site or off-site impoundment.

- Contain the unnatural sediment (cap, cover, engineered wetlands).
- Implement institutional controls (additional fencing, warning signs).
- No further action (other than IWTP).

Each of the potential general response actions will be evaluated in the Focused South Ditch Feasibility Study. Because the South Ditch is located within the 100-year floodplain, the evaluation will need to consider appropriate permit requirements. Remedial activities in floodplains may require permits from county and/or local agencies, the U.S. Army Corps of Engineers, Illinois Department of Natural Resources, and IEPA. The first step of the Focused Feasibility Study will be development of an Alternatives Array Document (AAD) which will assemble a group of potential remedial action alternatives for IEPA review. Each of these remedial action alternatives will address one or more of the remedial action objectives in an effort to develop a comprehensive remedy for the Study Area. Any expedited remedial action chosen for the Study Area must consider compatibility with the potential site-wide remedy. Following approval of the AAD, a detailed analysis of remedial action alternatives will be performed as the last component of the Focused South Ditch Feasibility Study.

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TABLE 2-1

SAMPLE MATRIX

SAMPLE NUMBER	SAMPLE LOCATION	SAMPLE DEPTH	ANALYSES PERFORMED					
			SAMPLE TYPE	TPL	GC	SPLP	AVS/SEM	MS/MSD
SD-001-000	transect 1	surface sample	unnatural sediment	X			X	
SD-001-111	transect 1	surface sample	unnatural sediment (dup)	X	X	X		
SD-001-02.0	transect 1	2 feet	unnatural sediment	X	X	X		
SD-001-04.0	transect 1	4 feet	unnatural sediment	X				
CB-001-06.0	transect 1	6 feet	channel bottom	X				
SD-003-000	transect 3	surface sample	unnatural sediment	X			X	X
SD-003-02.0	transect 3	2 feet	unnatural sediment	X	X	X		
SD-003-333	transect 3	2 feet	unnatural sediment (dup)	X	X	X		
SD-003-04.5	transect 3	4.5 feet	unnatural sediment	X				
CB-003-06.0	transect 3	6 feet	channel bottom	X				
SD-005-000	transect 5	surface sample	unnatural sediment	X			X	
SD-005-01.5	transect 5	1.5 feet	unnatural sediment	X	X	X		
SD-005-555	transect 5	1.5 feet	unnatural sediment (dup)	X	X	X		
SD-005-03.0	transect 5	3 feet	unnatural sediment	X				
CB-005-04.5	transect 5	4.5 feet	channel bottom	X	X			
CB-005-555	transect 5	4.5 feet	channel bottom (dup)	X				
SD-007A-000	transect 7A	surface sample	unnatural sediment	X			X	
SD-007A-02.0	transect 7A	2 feet	unnatural sediment	X	X	X		
SD-007A-03.5	transect 7A	3.5 feet	unnatural sediment	X				
CB-007A-04.5	transect 7A	4.5 feet	channel bottom	X				
SD-007B-000	transect 7B	surface sample	unnatural sediment	X				
SD-007B-02.0	transect 7B	2 feet	unnatural sediment	X	X	X		
SD-007B-03.0	transect 7B	3 feet	unnatural sediment	X				
CB-007B-04.0	transect 7B	4 feet	channel bottom	X				
SD-009A-000	transect 9A	surface sample	unnatural sediment	X			X	X
SD-009A-02.5	transect 9A	2.5 feet	unnatural sediment	X	X	X		
SD-009A-05.5	transect 9A	5.5 feet	unnatural sediment	X				
CB-009A-06.5	transect 9A	6.5 feet	channel bottom	X				
SD-009B-000	transect 9B	surface sample	unnatural sediment	X				
SD-009B-02.0	transect 9B	2 feet	unnatural sediment	X	X	X		
SD-009B-05.0	transect 9B	5 feet	unnatural sediment	X				
CB-009B-06.0	transect 9B	6 feet	channel bottom	X				
SD-011-000	transect 11	surface sample	unnatural sediment	X			X	
SD-011-02.5	transect 11	2.5 feet	unnatural sediment	X	X	X		
SD-011-04.0	transect 11	4 feet	unnatural sediment	X				
CB-011-05.5	transect 11	5.5 feet	channel bottom	X				

TABLE 2-1

SAMPLE MATRIX

SAMPLE NUMBER	SAMPLE LOCATION	SAMPLE DEPTH	ANALYSES PERFORMED					
			SAMPLE TYPE	TPL	GC	SPLP	AVS/SEM	MS/MSD
SD-013A-000	transect 13A	surface sample	unnatural sediment	X			X	X
SD-013A-02.5	transect 13A	2.5 feet	unnatural sediment	X	X	X		
SD-013A-05.5	transect 13A	5.5 feet	unnatural sediment	X				
CB-013A-07.5	transect 13A	7.5 feet	channel bottom	X	X			
SD-013B-000	transect 13B	surface sample	unnatural sediment	X				
SD-013B-02.5	transect 13B	2.5 feet	unnatural sediment	X	X	X		X
SD-013B-05.5	transect 13B	5.5 feet	unnatural sediment	X				
CB-013B-07.5	transect 13B	7.5 feet	channel bottom	X				
SD-014-000	transect 14	surface sample	unnatural sediment	X			X	
SD-014-111	transect 14	surface sample	unnatural sediment (dup)	X				
SD-014-02.5	transect 14	2.5 feet	unnatural sediment	X	X	X		
SD-014-222	transect 14	2.5 feet	unnatural sediment (dup)	X	X	X		
CB-014-03.5	transect 14	3.5 feet	channel bottom	X				
SD-015-000	Turner Lake	surface sample	background sediment	X	X			
SD-016-000	Turner Lake	surface sample	background sediment	X	X			
SD-017-000	Turner Lake	surface sample	background sediment	X				
SD-018-000	Turner Lake	surface sample	background sediment	X				

TABLE 3-1

UNNATURAL SEDIMENT VOLUME CALCULATION

TRANSECT	WEST TO EAST					AVERAGE DEPTH [1] (ft)	AREA BETWEEN TRANSECTS (ft^2)	VOLUME (yd^3)
	SEDIMENT THICKNESS PROFILE 1 (ft)	SEDIMENT THICKNESS PROFILE 2 (ft)	SEDIMENT THICKNESS PROFILE 3 (ft)	SEDIMENT THICKNESS PROFILE 4 (ft)	SEDIMENT THICKNESS PROFILE 5 (ft)			
Main Ditch								
Head of Ditch	-	-	-	-	-			
						4.2	937	147
1	4.0	5.1	3.6	-	-			
						3.9	3480	498
2	2.8	4.8	2.9	-	-			
						4.1	3614	547
3	4.8	5.0	4.2	-	-			
						4.1	5131	779
4	3.0	5.0	2.6	-	-			
						3.6	4015	540
5	3.3	3.5	4.4	-	-			
						3.8	6718	954
6	4.1	4.4	3.3	-	-			
						3.6	3716	499
7	3.6	3.0	3.0	4.0	-			
						4.1	3949	593
8	4.0	4.8	6.0	-	-			
						5.1	3142	596
9	1.6	5.8	6.6	6.2	6.0			
						5.2	4909	948
10	5.5	5.0	5.0	-	-			
						5.1	2931	555
11	5.4	4.7	4.6	5.6	-			
						5.1	1434	270
12	5.1	5.2	5.0	-	-			
						6.1	3471	778
13	6.4	6.6	6.5	6.8	6.8			
West Branch								
14	3.5	2.6	2.9	-	-	3.0	1371	152
Total								7857

1 "AVERAGE DEPTH" is the average unnatural sediment thickness profile taken from two adjacent transects.
Example: TR1 - TR2 average unnatural sediment thickness = (4.0 + 5.1 + 3.6 + 2.8 + 4.8 + 2.9) / 6 =3.9 ft

TABLE 3-2
SUMMARY RESULTS OF SEDIMENT PHYSICAL CHARACTERIZATION

Sample Number	Moisture Content		Density		Atterberg Limits				Grain Size Distribution	
	Water Content	Percent Solids	Wet Density (lb/ft^3)	Dry Density (lb/ft^3)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Percent Sand	Percent Fines
SD-07	276%	27%	66.62	17.73	134	109.00	25	7	24.0	76.0
SD-09	284%	26%	69.44	18.09	NA	NA	NA	NA	30.1	69.9
SD-11	318%	24%	75.85	18.13	NA	NA	NA	NA	33.5	66.5

Notes:

NA - Indicates not analyzed.

TABLE 3-3
SUMMARY OF GENERAL CHEMISTRY RESULTS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-001-02.0	SD-001-111	SD-003-02.0	SD-003-333	SD-005-01.5
QC Sample		Dup of SD-001-02.0		Dup of SD-003-02.0	
Laboratory Sample ID	347100	347099	347092	347091	347097
Sampling Date	3/5/96	3/5/96	3/5/96	3/5/96	3/4/96
Compound	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm
Alkalinity - 10% Solution (1)	8,560	7,430	43,400	45,400	4,800
N-Ammonia	IS	IS	IS	IS	IS
pH, Non aqueous(st. units)	7.12	6.64	6.82	6.73	6.93
Sulfate-10% solution	7450	26,100	83,500	87,100	6,880
Sulfide	IS	IS	IS	IS	IS
Total Organic Carbon	4,500 S	3,700 S	37,000 S	24,000 S	4,900 S
Cation Exchange Capacity(meq/100gm)	IS	IS	IS	IS	IS
CEC - Calcium	IS	IS	IS	IS	IS
CEC - Magnesium	IS	IS	IS	IS	IS
CEC - Sodium	IS	IS	IS	IS	IS
CEC - Potassium	IS	IS	IS	IS	IS
Calcium, AA	21,000	24,000	64,000	140,000	27,000
Magnesium, AA	8,300	13,000	19,000	41,000	12,000
Potassium, AA	1,100	1,600	3,900	6,900	2,000
Sodium, AA	1,700	1,700	11,000	11,000	1,500
Aluminum,ICP	12,400	13,000	15,000	47,000	11,600
Barium, ICP	2,600	1,110	2,300	4,140	805
Iron, ICP	94,000	63,000	180,000	443,000	56,300
Silicon, ICP	8,950	12,000	24,000	55,800	6,800
Solids, Total (%)	14.5	11.5	2.0	2.1	23.4

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-3
SUMMARY OF GENERAL CHEMISTRY RESULTS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-005-555	CB-005-04.5	SD-007A-02.0	SD-007B-02.0	SD-009A-02.5
QC Sample	Dup of SD-005-01.5				
Laboratory Sample ID	347098	347093	346882	346883	346879
Sampling Date	3/4/96	3/4/96	3/1/96	3/1/96	2/29/96
Compound	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm
Alkalinity - 10% Solution (1)	5,570	1,580	7,450	2,540	2,710
N-Ammonia	IS	44.3	323	492	461
pH, Non aqueous(st. units)	6.85	7.29	7.00	7.01	7.24
Sulfate-10% solution	9,600	1,710	9,780	11,300	5,990
Sulfide	IS	9.2	4.4 U	5.6 U	4.5
Total Organic Carbon	6,000 S	3,600 S	8,850 S	9,940 S	9,480 S
Cation Exchange Capacity(meq/100gm)	IS	9.9	5.2	5.7	7.8
CEC - Calcium	IS	120	61	72	110
CEC - Magnesium	IS	35	18	17	20
CEC - Sodium	IS	21	13	14	12
CEC - Potassium	IS	3.9	3.4	4.3	4.9
Calcium, AA	15,000	36,000	190	340	260
Magnesium, AA	5,400	8,800	220	240	210
Potassium, AA	820	1,200	3,500	8,100	5,700
Sodium, AA	1,800	640	50 U	50 U	50 U
Aluminum,ICP	6,000	8,400	12,900	9,230	8,250
Barium, ICP	417	71	850	654	544
Iron, ICP	59,400	70,000	44,000	52,100	42,500
Silicon, ICP	7,290	2,700	15,400	13,000	11,100
Solids, Total (%)	17.7	52.4	22.6	17.7	26.7

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-3
SUMMARY OF GENERAL CHEMISTRY RESULTS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-009B-02.0	SD-011-02.5	SD-013A-02.5	CB-013A-07.5	SD-013B-02.5
QC Sample					
Laboratory Sample ID	346881	346880	347095	347094	347096
Sampling Date	3/1/96	2/29/96	3/4/96	3/4/96	3/4/96
Compound	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm
Alkalinity - 10% Solution (1)	1,310	5,090	3,420	2,200	8,400
N-Ammonia	313	533	497	36.7	447
pH, Non aqueous(st. units)	7.44	7.89	7.74	8.06	7.73
Sulfate-10% solution	2,760	4,780 MXU	1,900 MXU	3,790	9,500 MXU
Sulfide	38.4	145	820	1.7	37
Total Organic Carbon	4,860 S	7,670 S	2,900 S	2,500 S	5,100 S
Cation Exchange Capacity(meq/100gm)	9.6	9.4	23	20	13
CEC - Calcium	130	130	270	220	170
CEC - Magnesium	30	30	100	61	48
CEC - Sodium	11	5.6	33	71	7.0
CEC - Potassium	7.6	7.4	3.6	22	15
Calcium, AA	560	900	29,000	7,100	28,000
Magnesium, AA	230	170	13,000	6,900	16,000
Potassium, AA	5,500	3,700	2,200	1,300	2,700
Sodium, AA	*50 U*	*50 U*	*250*	*130*	*280*
Aluminum,ICP	10,100	8,400	18,000	16,000	19,500
Barium, ICP	1,110	1,130	522	337	473
Iron, ICP	24,500	39,800	33,000	27,000	33,400
Silicon, ICP	5,200	7,590	5,330	1,500	2,300
Solids, Total (%)	51.8	52.3	52.1	65.9	52.9

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-3
SUMMARY OF GENERAL CHEMISTRY RESULTS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-014-02.5	SD-014-222	SD-015-000	SD-016-000	Rinsate #3
QC Sample		Dup of SD-014-02.5			Rinsate
Laboratory Sample ID	347101	347102	347315	347317	347103
Sampling Date	3/5/96	3/5/96	3/8/96	3/8/96	3/4/96
Compound	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/gm	Concentration µg/L
Alkalinity - 10% Solution (1)	1,730	2,250	2,650	1,880	5 U
N-Ammonia	IS	337	200	80.3	0.50 U
pH, Non aqueous(st. units)	7.49	7.28	7.52	7.66	NA
Sulfate-10% solution	463	1,750	100 U	100 U	10 U
Sulfide	IS	26	122	45	0.10 U
Total Organic Carbon	1,100 S	2,800 S	2,700	2,700 S	1.0 U
Cation Exchange Capacity(meq/100gm)	IS	IS	17	20	NA
CEC - Calcium	IS	IS	230	300	NA
CEC - Magnesium	IS	IS	58	49	NA
CEC - Sodium	IS	IS	4.5	4.5	NA
CEC - Potassium	IS	IS	16	15	NA
Calcium, AA	40,000	6,600	26,000	18,000	1.0 U
Magnesium, AA	23,000	20,000	15,000	9,700	1.0 U
Potassium, AA	810	1,900	2,600	2,300	1.0 U
Sodium, AA	370	730	190	170	1.0 U
Aluminum,ICP	6,100	8,100	19,000	18,000	0.10 U
Barium, ICP	193	520	140	150	0.020 U
Iron, ICP	24,000	37,000	27,000	27,000	0.050 U
Silicon, ICP	2,500	4,700	3,500	2,600	1.0 U
Solids, Total (%)	62.8	41.9	51.3	61.3	NA

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-3
SUMMARY OF GENERAL CHEMISTRY RESULTS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	Rinsate #4	Rinsate #5
QC Sample	Rinsate	Rinsate
Laboratory Sample ID	347104	347105
Sampling Date	3/5/96	3/5/96
Compound	Concentration µg/L	Concentration µg/L
Alkalinity - 10% Solution (1)	5 U	5 U
N-Ammonia	0.50 U	0.50 U
pH, Non aqueous(st. units)	NA	NA
Sulfate-10% solution	10 U	10 U
Sulfide	0.10 U	0.10 U
Total Organic Carbon	1.0 U	1.0 U
Cation Exchange Capacity(meq/100gm)	NA	NA
CEC - Calcium	NA	NA
CEC - Magnesium	NA	NA
CEC - Sodium	NA	NA
CEC - Potassium	NA	NA
Calcium, AA	1.0 U	1.0 U
Magnesium, AA	1.0 U	1.0 U
Potassium, AA	1.0 U	1.0 U
Sodium, AA	1.0 U	1.0 U
Aluminum,ICP	0.10 U	0.10 U
Barium, ICP	0.020 U	0.020 U
Iron, ICP	1.51 U	0.050 U
Silicon, ICP	1.0 U	1.0 U
Solids, Total (%)	NA	NA

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-4
QUALIFIER LEGEND

IS =	Insufficient sample volume to complete analysis.
U =	Analyte was not detected. The result of the analyte is less than the Instrument Detection Limit(IDL).
B =	If the reported value is less than the Contract Required Detection Limit (CRDL), but greater than the Instrument Detection Limit (IDL).
M =	Duplicate injection precision not met.
N =	Spike sample recovery not within control limits.
S =	The reported value was determined by the Method of Standard Addition(MSA).
W =	Postdigested spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
X =	Compound values that are flagged with an "X" have been edited on our Foremaster data reporting system.
"+" =	Correlation coefficient for the MSA is less than 0.995.
"*" =	Duplicate analysis not within control limits.
NA =	Not Analyzed

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-001-000	SD-001-02.0	SD-001-111	SD-001-04.0	CB-001-06.0	SDMS/MSD-003-000
QC Samples			Dup. of SD-001-02.0			MS/MSD
Laboratory Sample ID	143809	143808	143807	143806	143805	143815
Sampling Date	3/5/96	3/5/96	3/5/96	3/5/96	3/5/96	3/4/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	28.4 BW	37.5 S	24.3 S	82.0	1.1 BW	26.1 B
Beryllium	2.3 U	1.6 B	2.4 U	1.7 B	0.29 B	2.8 U
Cadmium	273	336	312	289	1.7	679
Chromium	19.5 B	15.9	11.9 U	17.1	6.3	13.9 U
Cobalt	47.6 B	44.3 B	51.8 B	37.3	2.4 B	66.2 B
Copper	86200	50300	97700	16200	165	67700
Lead	1430	2020	1740	2620	33.7	1090
Manganese	1830	1700	1940	2470	82.5	3080
Mercury	1.1 U	0.79 U	1.2 U	2.0	0.14 U	1.4 U
Nickel	56.8 U	39.4 U	59.5 U	29.7	8.1 B	69.4 U
Selenium	2.3 U	2.0 B	2.4 U	3.0 B	0.38 B	2.8 U
Silver	6.8 U	7.5 B	7.1 U	11.7	0.83 U	8.3 U
Vanadium	16.5 B	18.1 B	9.5 U	15.9 B	10.6 B	11.1 U
Zinc	77800	87800	98200	61800	559	189000

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-003-02.0	SD-003-333	SD-003-04.5	CB-003-06.0	SD-005-000	SD-005-01.5
QC Samples		Dup. of SD-003-02.0				
Laboratory Sample ID	143816	143817	143818	143819	143810	143811
Sampling Date	3/5/96	3/5/96	3/5/96	3/5/96	3/4/96	3/4/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	14.1 BS	21.8 BW	26.3	9.7 BW	8.4 B	15.7 BW
Beryllium	1.6 U	2.4 U	0.72 B	1.1 U	1.9 B	2.0 U
Cadmium	674	662	424 *	9.1 *	687	345
Chromium	10.1 B	11.9 U	10.1	5.5 U	6.2 U	9.9 U
Cobalt	64.4 B	57.5 B	50.7	4.5 B	65.1	48.6 B
Copper	46200	57600	13600 *	188 *	82900	47100
Lead	828	783	668 *	5.4 *	580	721
Manganese	3090	2720	3130	628	2900	2000
Mercury	0.96	1.2 U	3.6	0.55 U	0.62 U	0.99 U
Nickel	51.0 B	59.5 U	21.0 B	27.3 U	32.6 B	49.5 U
Selenium	1.6 U	2.4 U	1.9 BN	1.1 UN	1.2 U	2.0 U
Silver	128	7.1 U	8.1 N	3.3 UN	3.7 U	5.9 U
Vanadium	13.5 B	9.5 U	11.3 B	4.4 U	5.0 U	12.0 B
Zinc	175000	167000	95300	678	204000	105000

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-005-555	SD-005-03.0	CB-005-04.5	CB-005-555	SD-007A-000	SD-007A-02.0
QC Samples	Dup. of SD-005-01.5			Dup. of CB-005-04.5		
Laboratory Sample ID	143812	143804	143814	143813	143732	143733
Sampling Date	3/4/96	3/4/96	3/4/96	3/4/96	3/1/96	3/1/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	30.5 S	15.8 S	56.4	62.8	22.9	18.7 S
Beryllium	1.5 U	0.78 B	0.88 B	0.69 B	1.5 B	1.3 B
Cadmium	910	114	79.3	83.4	845	395
Chromium	9.8 B	17.5	13.4	19.1	14.2	15.8
Cobalt	60.6 B	21.8	30.5	26.7	61.1	40.8 B
Copper	50600	4180	2360	1750	39900	50300
Lead	1060	523	1760	1620	686 S	747 S
Manganese	2680	1250	1310	1350	2580	1410
Mercury	0.77 U	0.46	0.56	2.1	0.57 U	0.44 U
Nickel	40.7 B	23.0	15.2	21.6	51.6	43.1
Selenium	2.0 B	1.3 B	2.1	2.8	1.1 U	0.89 U
Silver	4.6 U	2.2 B	12.8	9.5	10.1 B*	5.2 B*
Vanadium	12.1 B	17.4 B	29.3	17.6	16.2 B	17.7 B
Zinc	183000	28400	23000	24200	147000	102000

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-007A-03.5	CB-007A-04.5	SD-007B-000	SD-007B-02.0	SD-007B-03.0	CB-007B-04.0
QC Samples						
Laboratory Sample ID	143734	143735	143736	143737	143738	143739
Sampling Date	3/1/96	3/1/96	3/1/96	3/1/96	3/1/96	3/1/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	17.9	4.4	19.0	9.7 BS	10.2 S	14.6
Beryllium	1.1 B	0.68 B	1.2 B	1.2 B	1.2 B	0.98 B
Cadmium	358	3.8	386	484	467	403
Chromium	27.8	14.9	18.0	21.2	20.3	31.7
Cobalt	32.8	55.4	40.7 B	46.1 B	38.8	48.4
Copper	20700	43.1	39700	32900	28500	741
Lead	465 S	14.2	650 S	1160	528 S	390
Manganese	1520	596	1530	2030	1880	1190
Mercury	0.31 U	0.20 U	0.47 U	0.52 U	0.35 U	1.2
Nickel	38.9	41.6	47.2	40.2 B	40.7	48.9
Selenium	0.72 B	0.39 UW	0.93 U	1.1 B	0.70 U	1.1 BW
Silver	2.5 B*	5.3 *	5.6 B*	6.7 B*	2.5 B*	3.4 B*
Vanadium	33.6	21.2	21.2 B	19.4 B	26.7 B	29.3
Zinc	75900	20400	79900	116000	100000	45700

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SDMS/MSD-009A-00	SD-009A-02.5	SD-009A-05.5	CB-009A-06.5	SD-009B-000	SD-009B-02.0
QC Samples	MS/MSD					
Laboratory Sample ID	143718	143719	143720	143721	143728	143729
Sampling Date	3/1/96	2/29/96	2/29/96	2/29/96	3/1/96	3/1/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	18.2	15.5	7.8	4.0 B	20.9	14.6
Beryllium	1.3 B	1.2 B	0.86 B	0.81 B	1.4 B	1.2 B
Cadmium	542	519	32.4	4.6	602	588
Chromium	13.8	16.3	23.0	16.6	15.8	23.7
Cobalt	59.4	54.1	15.3 B	10.5 B	60.2	55.3
Copper	41100	30700	257	69.1	44500	26300
Lead	528 S	491 S	156	25.3	559 S	480 S
Manganese	2180	2200	433	301	2340	3020
Mercury	0.51 U	0.37 U	2.8	0.22 U	0.59 U	0.31 U
Nickel	45.9	45.8	29.0	23.7	46.0 B	43.4
Selenium	1.0 B	0.74 U	0.57 B	0.54 B	1.2 U	0.62 U
Silver	8.3 B*	14.7 *	5.5 *	4.4 *	5.4 B*	4.4 B*
Vanadium	12.6 B	16.9 B	27.1	23.9	12.8 B	24.0
Zinc	157000	141000	5470	385	161000	148000

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-009B-05.0	CB-009B-06.0	SD-011-000	SD-011-02.5	SD-011-04.0	CB-011-05.5
QC Samples						
Laboratory Sample ID	143730	143731	143723	143724	143725	143726
Sampling Date	3/1/96	3/1/96	2/29/96	2/29/96	2/29/96	2/29/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	45.6	3.7 B	15.9	19.6	14.7	3.9 B
Beryllium	0.87 B	0.79 B	1.6 B	0.89 B	1.1 B	1.0 B
Cadmium	109	6.7	541	240	70.2	2.9
Chromium	28.1	17.2	21.3	34.7	61.5	27.0
Cobalt	70.2	12.2 B	50.0	37.1	17.6 B	12.6 B
Copper	2060	101	48900	4840	194	34.6
Lead	3440	49.8	522 S	288 S	364 S	33.4
Manganese	2520	402	1670	1400	619	291
Mercury	4.6	0.22 U	0.40 U	0.55	2.0	0.27
Nickel	35.3	26.1	52.1	43.9	38.0	31.4
Selenium	4.6	0.56 B	0.80 U	1.5 B	3.5	0.63 B
Silver	26.1 *	2.2 B*	3.2 B*	4.6 *	3.4 B*	2.6 B*
Vanadium	27.9	23.8	20.2 B	25.8	38.0	30.1
Zinc	20900	1130	132000	50400	4950	692

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SDMS/MSD-013A-00	SD-013A-02.5	SD-013A-05.5	CB-013A-07.5	SD-013B-000	SDMS/MSD-013B-02
QC Samples	MS/MSD					MS/MSD
Laboratory Sample ID	143825	143827	143828	143829	143830	143826
Sampling Date	3/4/96	3/4/96	3/4/96	3/4/96	3/4/96	3/4/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	14.4	15.9	11.1	4.7	12.9	12.7
Beryllium	1.2 B	1.0 B	1.1 B	0.85 B	1.2 B	1.0 B
Cadmium	316 *	333 *	60.5 *	4.7 *	367 *	159 *
Chromium	21.8	78.2	63.0	17.5	25.7	64.8
Cobalt	62.3	22.5	15.8 B	18.1	58.2	34.7
Copper	22300 *	232 *	144 *	28.1 *	19400 *	450 *
Lead	405 *	389 *	369 *	36.5 *	334 *	379 *
Manganese	2130	819	553	2660	2250	981
Mercury	0.59	0.89	2.9	0.42	0.46	0.57
Nickel	60.3	50.3	39.6	36.8	57.1	55.7
Selenium	2.0 BWN	4.0 SN	4.0 N	0.61 BN	1.8 BN	2.3 N
Silver	1.9 BN	10.3 N	43.0 N	2.1 BN	144 N	3.9 BN
Vanadium	19.5 B	26.3	29.5	21.1	21.0 B	29.6
Zinc	113000	12500	3840	355	100000	17400

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-013B-05.5	CB-013B-07.5	SD-014-000	SD-014-111	SD-014-02.5	SD-014-222
QC Samples				Dup. of SD-014-000		Dup. of SD-014-02.5
Laboratory Sample ID	143831	143832	143820	143821	143822	143823
Sampling Date	3/4/96	3/4/96	3/5/96	3/5/96	3/5/96	3/5/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Arsenic	17.4	2.7 B	8.2 B	8.6 B	8.2	14.2
Beryllium	0.86 B	0.83 B	0.95 B	0.98 B	0.38 B	0.58 B
Cadmium	45.2 *	3.1 *	405 *	375 *	68.6 *	121 *
Chromium	34.4	15.7	13.3	16.4	7.2	14.4
Cobalt	19.8	16.8	31.3 B	32.6 B	8.1 B	15.0 B
Copper	155 *	21.7 *	15300 *	13800 *	2020 *	5050 *
Lead	409 *	17.8 S*	234 *	308 *	125 *	269 *
Manganese	658	6730	2000	2000	683	940
Mercury	2.0	0.14 U	0.45 U	0.48 U	0.20	0.37
Nickel	31.5	34.7	25.2 B	27 B	11.6 B	18.8
Selenium	2.7 N	0.63 BN	0.91 UN	1.4 BWN	0.57 BN	1.0 BN
Silver	2.0 BN	1.3 BN	2.7 UN	27.8 N	33.6 N	1.4 UN
Vanadium	23.4	19.5	16.1 B	19.9 B	11.8 B	21.0 B
Zinc	4690	104	103000	92100	14200	27300

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	CB-014-03.5	SD-015-000	SD-016-000	SD-017-000	SD-018-000	Rinsate #1
QC Samples						Rinsate
Laboratory Sample ID	143824	143848	143849	143850	143851	143722
Sampling Date	3/5/96	3/8/96	3/8/96	3/8/96	3/8/96	2/29/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration µg/L
Arsenic	2.5 BW	10.3	8.7	6.9	6.9	2.0 U
Beryllium	0.59 U	0.88 B	0.83 B	0.88 B	0.88 B	1.0 U
Cadmium	4.4 *	8.0 *	5.5 *	3.4 *	3.8 *	3.0 U
Chromium	10.8	47.7	44.6	34.5	34.6	5.0 U
Cobalt	3.9 B	9.7 B	10.0 B	10.0 B	10.1 B	4.0 U
Copper	24.7 *	46.1 *	43.3 *	36.1 *	39.2 *	13.6 B
Lead	31.2 *	55.7 *	49.7 *	36.9 *	52.6 *	2.0 UW
Manganese	923	621	609	524	532	3.0 U
Mercury	0.80	0.19 U	0.17 U	0.19 U	0.20 U	0.20 U
Nickel	14.8 U	41.2	37.1	34.3	36.8	25.0 U
Selenium	1.4 BN	0.82 BN	0.72 BN	0.56 BN	0.48 BN	1.0 U
Silver	1.8 BN	1.1 UN	1.0 UN	1.1 UN	1.2 UN	4.7 B
Vanadium	12.5 B	25.6	23.8	28.6	27.9	4.0 U
Zinc	213	370	259	163	169	47.0

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-5
SUMMARY OF TPL METAL CONCENTRATIONS[1]
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	Rinsate #2	Rinsate #3	Rinsate #4	Rinsate #5
QC Samples	Rinsate	Rinsate	Rinsate	Rinsate
Laboratory Sample ID	143727	143833	143834	143835
Sampling Date	3/1/96	3/4/96	3/5/96	3/5/96
Compound	Concentration µg/L	Concentration µg/L	Concentration µg/L	Concentration µg/L
Arsenic	2.0 U	2.0 U	2.0 U	2.0 U
Beryllium	1.0 U	1.0 U	1.0 U	1.0 U
Cadmium	3.0 U	3.0 U	3.0 U	3.0 U
Chromium	5.0 U	5.0 U	5.0 U	5.0 U
Cobalt	4.0 U	4.0 U	4.0 U	4.0 U
Copper	10.4 B	4.0 U	4.0 U	4.0 U
Lead	2.0 UW	2.0 U	2.7 B	2.0 UW
Manganese	3.0 U	3.0 U	3.0 U	3.0 U
Mercury	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	25.0 U	25.0 U	25.0 U	25.0 U
Selenium	1.0 U	1.0 U	1.0 U	1.0 U
Silver	3.0 U	5.2 B	3.0 U	3.0 U
Vanadium	4.0 U	4.0 U	4.0 U	4.0 U
Zinc	26.1	10.3 B	12.2 B	16.7 B

[1] Metal concentrations reported on a dry weight basis.

TABLE 3-6
SUMMARY OF SPLP METAL CONCENTRATIONS
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-001-111	SD-001-02.0	SD-003-02.0	SD-003-333	SD-005-01.5	SD-005-555
QC Samples	Dup. of SD-001-000			Dup. of SD-003-02.0		Dup. of SD-005-01.5
Laboratory Sample ID	347099	347100	347092	347091	347097	347098
Sampling Date	3/5/96	3/5/96	3/5/96	3/5/96	3/4/96	3/4/96
Compound	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L
Arsenic	0.005 U	0.005 U	0.005 U	0.163	0.005 U	0.005 U
Beryllium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cadmium	0.370	0.061	0.051	0.090	0.037	0.035
Chromium	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Cobalt	0.213	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Copper	1.63	0.332	0.360	0.424	0.462	0.330
Lead	0.005 U	0.005 U	0.005 U	0.007	0.005 U	0.005 U
Manganese	13	1.80	3.61	5.30	1.64	1.51
Mercury	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U
Nickel	0.102	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Selenium	0.005 U	0.005 U	0.005 M+U	0.035	0.005 U	0.005 U
Silver	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Vanadium	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Zinc	116	9.28	21.3 M+	32	9.47	11

TABLE 3-6
SUMMARY OF SPLP METAL CONCENTRATIONS
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-007A-02.0	SD-007B-02.0	SD-009A-02.5	SD-009B-02.0	SD-011-02.5	SD-013A-02.5
QC Samples						
Laboratory Sample ID	346882	346883	346879	346881	346880	347095
Sampling Date	3/1/96	3/1/96	2/29/96	3/1/96	2/29/96	3/4/96
Compound	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L	Concentration mg/L
Arsenic	0.005 U	0.005 U	0.005 U	0.005	0.007	0.005 U
Beryllium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cadmium	0.056	0.045	0.039	0.010 U	0.015	0.013
Chromium	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Cobalt	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Copper	0.262	0.103	0.212	0.078	0.448	0.025
Lead	0.005 U	0.005 U	0.005 U	0.017	0.074	0.018
Manganese	2.33	2.26	0.483	0.315	0.183	0.031
Mercury	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U	0.0004 U
Nickel	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Selenium	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Silver	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Vanadium	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U
Zinc	15	11	3.95	1.37	3.19	0.630

TABLE 3-6
SUMMARY OF SPLP METAL CONCENTRATIONS
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-013B-02.5	SD-014-02.5	SD-014-222
QC Samples			Dup. of SD-014-02.5
Laboratory Sample ID	347096	347101	347102
Sampling Date	3/4/96	3/5/96	35129
Compound	Concentration mg/L	Concentration mg/L	Concentration mg/L
Arsenic	0.019	0.005 U	0.005 U
Beryllium	0.005 U	0.005 U	0.005 U
Cadmium	0.041	0.010 U	0.013
Chromium	0.040 U	0.040 U	0.040 U
Cobalt	0.10 U	0.10 U	0.10 U
Copper	0.210	0.387	0.190
Lead	0.116	0.008	0.005 U
Manganese	0.308	0.284	0.280
Mercury	0.0004 U	0.0004 U	0.0004 U
Nickel	0.050 U	0.050 U	0.050 U
Selenium	0.005 U	0.005 U	0.005 U
Silver	0.040 U	0.040 U	0.040 U
Vanadium	0.050 U	0.050 U	0.050 U
Zinc	3.80	1.44	1.18

TABLE 3-7
SUMMARY OF AVS / SEM CONCENTRATIONS
SOUTH DITCH UNNATURAL SEDIMENT

Golder Sample ID	SD-001-000	SD-003-000	SD-005-000	SD-007-000	SD-009-000	SD-011-000	SD-013-000	SD-014-000
Laboratory Sample ID	293610	293611	293119	293120	293121	293122	293123	293612
Sampling Date	3/5/96	3/5/96	3/4/96	3/1/96	2/29/96	2/29/96	3/4/96	3/5/96
Compound	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg	Concentration mg/kg
Acid Volatile Sulfides	<26.6	<33.6	<34.3	<21.6	<28.0	<23.0	<15.1	424
Arsenic	12.4	5.6	5.9	6.5	7.2	6.6	5.2	5.8
Beryllium	0.61	0.57	1.1	0.71	1.0	0.81	0.70	0.92
Cadmium	86	120	250	184	280	280	175	390
Chromium	10.5	3.5	2.9	4.0	4.7	7.3	9.3	6.3
Cobalt	13.6	16.8	27	18.4	35	27	31	26.1
Copper	34000	40000	67000	46000	48000	42000	22000	26000
Lead	520	330	330	270	290	240	176	280
Manganese	470	710	1020	550	1160	1030	1060	1620
Mercury	0.112	0.101	0.045	0.080	0.083	0.083	0.090	0.075
Nickel	21	16.7	22	19.3	31	24	30	20
Selenium	<1	<1	<2	<0.9	<2	<0.9	<0.6	<2
Silver	2.3	<2	<2	<2	<2	<2	<1	<2
Vanadium	12.8	5.6	5.0	6.8	6.5	7.5	9.1	8.9
Zinc	39000	114000	197000	140000	210000	166000	132000	170000
Solids, Percent	18.8	14.6	14.3	23.2	17.5	21.3	31.7	12.7

TABLE 3-8
MORTALITY RESULTS - CHIRONOMUS TENTANS
SOUTH DITCH UNNATURAL SEDIMENT

TRANSECT NUMBER	PERCENT MORTALITY AFTER 4 DAYS
TR-001	100
TR-003	100
TR-005	100
TR-007	100
TR-009	100
TR-011	100
TR-013	85
TR-014	100
B-1	22
B-2	35
CONTROL	8

TABLE 3-9
MORTALITY RESULTS - HYALELLA AZTECA
SOUTH DITCH UNNATURAL SEDIMENT

TRANSECT NUMBER	PERCENT MORTALITY AFTER 4 DAYS
TR-001	100
TR-003	100
TR-005	100
TR-007	100
TR-009	100
TR-011	100
TR-013	100
TR-014	100
B-1	22
B-2	23
CONTROL	10

TABLE 4-1
WATER QUALITY FOR SOUTH DITCH FLOW COMPONENTS

Sample Data				Indicator Parameters			Major Ions											Minor Ions		
Flow Component	Sample Location	Date	Sampling Entity	pH	DO mg/L	TSS mg/L	Ca mg/L	Mg mg/L	Fe mg/L	Na mg/L	K mg/L	Cl mg/L	SO_4 mg/L	S^{2-} mg/L	Alkalinity mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	PO_4 mg/L	F mg/L
Center IRM Wall	Pit Center	1/91-10/94	ZCA	5.19	NA	58.3	NA	NA	63.25	NA	NA	NA	13258	NA	NA	NA	NA	9.62	1.34	2
South IRM Wall	Pit East	1/91-10/94	ZCA	5.56	NA	41	NA	NA	8.3	NA	NA	NA	11139	NA	NA	NA	NA	106.7	1.8	2.4
NPDES	Location III	1/91-10/94	Terra	7.35	3.2	108	330	140	5.2	NA	NA	25	1108	<1	210	5.2	0.2	9.9	9	5.9
Groundwater	PS-10	3/9/94	Terra	6.4	NA	NA	260	120	16.0	NA	NA	18	700	<1	630	<0.1	<0.1	20.0	NA	0.4
South Ditch	S-101	4/29/93	IEPA	6.6**	5.8**	NA	308	192	14.1	115	24.6	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Data				Metals																	
Flow Component	Sample Location	Date	Sampling Entity	Ag mg/L	Al mg/L	As mg/L	Ba mg/L	Be mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Hg mg/L	Mn mg/L	Ni mg/L	P mg/L	Pb mg/L	Sb mg/L	Se mg/L	Tl mg/L	V mg/L	Zn mg/L
Center IRM Wall	Pit Center	1/91-10/94	ZCA	NA	NA	NA	NA	NA	12.61	NA	NA	180.3	NA	656.5	5.4	NA	1.58	NA	NA	NA	NA	5843
South IRM Wall	Pit East	1/91-10/94	ZCA	NA	NA	NA	NA	NA	10.89	NA	NA	214	NA	559	4.65	NA	1.51	NA	NA	NA	NA	5133
North Ditch	SW-3	1/91-10/94	Terra	NA	NA	0.006	0.03	NA	2	NA	NA	1.54	NA	1.76	0.07	2.3	[illegible]	NA	<0.005	NA	NA	146.9
Groundwater	PS-10	3/9/94	Terra	NA	NA	<0.005	0.10	NA	<0.0005	NA	NA	<0.01	NA	0.59	0.02	2.7	[illegible]	NA	<0.005	NA	NA	<0.02
South Ditch	S-101	4/29/93	IEPA	<0.0048	4.6	0.0031	0.12	0.0028	5.6	3.2	<0.0046	84.4	<0.00020	201	1.7	NA	0.48	<0.068	0.032	<0.0065	<0.0060	1790

Notes:

** - Indicated value are an average of 8 measurements completed during Focused RI.

NA - Not Analyzed

ZCA - Zinc Corporation of America

Terra - Terra Environmental Services, Inc.

IEPA - Illinois Environmental Protection Agency

Analytical results for the NPDES discharge are a combination of data from a one-time sampling event at location SW-3 in the North Ditch (SAP, Table 9.14) and weekly data from Location III in the existing sump.

Ag - Silver
Al - Aluminum
As - Arsenic
Ba - Barium
Be - Beryllium
Ca - Calcium
Cd - Cadmium
Cl - Chloride
Co - Cobalt
Cr - Chromium
Cu - Copper
DO - Dissolved Oxygen
F - Fluoride
Fe - Iron
Hg - Mercury
K - Potassium
Mg - Magnesium
Mn - Manganese
Na - Sodium
NH_3 - Ammonia
Ni - Nickel
NO_2 - Nitrite
NO_3 - Nitrate
P - Phosphorous
Pb - Lead
PO_4 - Phosphate
Sb - Antimony
Se - Selenium
SO_4 - Sulfate
S^{2-} - Sulfide
Tl - Thallium
TSS - Total Suspended Solids
V - Vanadium
Zn - Zinc

TABLE 5-1
COMPARISON OF MAXIMUM DETECTED TPL METAL CONCENTRATIONS TO SEDIMENT QUALITY GUIDELINES AND CRITERIA[6]
SOUTH DITCH UNNATURAL SEDIMENT

Compound	Maximum South Ditch Concentration mg/kg	Maximum Turner Lake Sediment Concentration mg/kg	OME Sediment Quality Guidelines[2]/BCE Sediment Quality Criteria[3] mg/kg		Frequency of Exceedance South Ditch Unnatural Sediment	Frequency of Exceedance Turner Lake Sediment
			LEL[4]	SEL[5]		
Arsenic	28.4*	10.3	6*	33	13/13 (LEL)	4/4 (LEL)
Beryllium	2.8 U	0.88	NA	NA	NA	NA
Cadmium	845	8.0	0.6	10	13/13 (LEL) 13/13 (SEL)	4/4 (LEL) 0/4 (SEL)
Chromium	25.7	47.7	26	110	NA	4/4 (LEL)
Cobalt	66.2	10.1	50[w]	NA	9/13 (LEL)	NA
Copper	97,700	46.1	16	110	13/13 (LEL) 13/13 (SEL)	4/4 (LEL) 0/4 (SEL)
Lead	1,740	55.7	31	250	13/13 (LEL) 12/13(SEL)	4/4 (LEL) 0/4 (SEL)
Manganese	3,080	621	460	1,100	13/13 (LEL) 13/13 (SEL)	4/4 (LEL) 0/4 (SEL)
Mercury	1.4 U	0.20 U	0.2	2.0	12/13 (LEL)	0/4 (LEL)
Nickel	69.4 U	41.2	16	75	13/13 (LEL)	4/4 (LEL)
Selenium	2.8 U	0.82	5[#]	NA	NA	NA
Silver	144	1.2 U	0.5	NA	13/13 (LEL)	4/4 (LEL)
Vanadium	21.2	28.6	NA	NA	NA	NA
Zinc	204,000	370	120	820	13/13 (LEL) 13/13 (SEL)	4/4 (LEL) 0/4 (SEL)

[1] Metal concentrations reported on a dry weight basis.
[2] From Persaud (1992).
[3] From Nagpal (1995).
[4] Lowest Effect Level.
[5] Severe Effect Level.
[6] Only surface sediment samples (0 to 6 inches) were included in the evaluation.
[#] From Nagpal (1995), but is not defined as an LEL. The value is based on the protection of aquatic life in freshwater.
[w] From Persaud (1992), but not in Nagpal (1995).
Shading indicates that the concentration exceeded the sediment quality guideline or criteria.
NA = No sediment quality guideline or criteria was available for comparison.
U = Analyte was not detected. The result of the analyte is less than the Instrument Detection Limit (IDL). See Table 3-5.

TABLE 5-2
EXPOSURE PARAMETERS FOR RISK-BASED SCREENING CONCENTRATIONS FOR THE CHILD TRESPASSER

Exposure Parameter	Value	Units	Source
soil ingestion rate	200	mg/d	TACAO, Appendix C, Table B (Residential)
exposure frequency (soil ingestion)	50	d/yr	scenario-specific
exposure frequency (Inhalation)	8.3	d/yr	scenario-specific
exposure duration	6	yr	scenario-specific
body weight	32	kg	Exposure Factors Handbook (EPA 1995), mean body weight for 9 year old boys and girls
averaging time	70 (carcinogens) 6 (noncarcinogens)	yr	TACAO, Appendix C, Table B (Residential)
target hazard quotient	1	unitless	TACAO, Appendix C, Table B
target cancer risk	$1x10^{-6}$	unitless	TACAO, Appendix C, Table B
particulate emission factor	$9.53x10^{7}$	m^3/kg	TACAO, Appendix C, Table B (adjusted for agitation)

TABLE 5-3
US EPA TOXICITY VALUES USED TO CALCULATE
SCREENING VALUES FOR THE CHILD TRESPASSER SCENARIO

Compound	Oral Reference Dose (mg/kg-d)	Inhalation Reference Concentration (mg/m^3)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Inhalation Unit Risk $(ug/m^3)^{-1}$
Arsenic	3E-04[1,5]	-	1.5E+00[2,4]	4.3E-03[2,4]
Beryllium	5E-03[1,5]	-	4.3E+00[2,4]	2.4E-03[2,4]
Cadmium	1E-03[2,4,7]	-	-	1.8E-03[2,4]
Chromium VI	2E-02[1,6]	-	-	1.2E-02[2,4]
Cobalt	6E-02[3,4]	-	-	-
Copper	4E-02[3,4]	-	-	-
Lead	-	-	-	-
Manganese	4.7E-02[2,4,8]	5E-05[2,4]	-	-
Mercury	-	3E-04[1,5]	-	-
Nickel	2E-02[1,5]	-	-	2.4E-04[2,4,9]
Selenium	5E-03[1,5]	-	-	-
Silver	5E-03[1,5]	-	-	-
Vanadium	7E-03[1,5]	-	-	-
Zinc	3E-01[1,5]	-	-	-

[1] Source is HEAST (US EPA, 1995)
[2] Source is IRIS (US EPA, 1996b)
[3] Source is STSC (US EPA 1992 for cobalt; US EPA 1991 for copper)
[4] Toxicity value for chronic exposures (subchronic value not available)
[5] Toxicity value for subchronic exposures (same value as for chronic exposures)
[6] Toxicity value for subchronic exposures (higher than value for chronic exposures)
[7] Oral reference dose for cadmium in food
[8] Oral reference dose for manganese in soil and water
[9] Inhalation unit risk for nickel refinery dust
- = Toxicity information not currently provided by US EPA

TABLE 5-4
COMPARISON OF MAXIMUM TPL METAL CONCENTRATIONS FROM SOUTH DITCH UNNATURAL SEDIMENT WITH CALCULATED RISK-BASED SCREENING CONCENTRATIONS FOR A CHILD TRESPASSER

Compound	Maximum South Ditch Concentration[1] (0 to 6 inches) mg/kg	Maximum South Ditch Concentration[1] (All samples) mg/kg	Calculated Risk-Based Screening Concentration Ingestion mg/kg	Calculated Risk-Based Screening Concentration Inhalation mg/kg	Frequency of Exceedance South Ditch (0 to 6 in.)	Frequency of Exceedance South Ditch (All samples)
Arsenic	28.4	82.0	55 (C)	31,000 (C)	0/13	3/49
Beryllium	2.8 U	2.8 U	19 (C)	56,000 (C)	0/13	0/49
Cadmium	845	910	1,200	27,000 (C)	0/13	0/49
Chromium	25.7	78.2	23,000	11,000 (C)	0/13	0/49
Cobalt	66.2	70.2	70,000	NA	0/13	0/49
Copper	97,700	97,700	47,000	NA	5/13	10/49
Lead	1,740	3,440	400[2]	NA	10/13	28/49
Manganese	3,080	6,730	55,000	96,000	0/13	0/49
Mercury	1.4 U	4.6	NA	57,000	0/13	0/49
Nickel	69.4 U	69.4 U	23,000	560,000 (C)	0/13	0/49
Selenium	2.8 U	4.6	5,800	NA	0/13	0/49
Silver	144	144	5,800	NA	0/13	0/49
Vanadium	21.2	38.0	8,200	NA	0/13	0/49
Zinc	204,000	204,000	350,000	NA	0/13	0/49

[1] Metal concentrations reported on a dry weight basis.

[2] A preliminary remediation goal of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive #9355.4-12.

All screening concentrations based on noncarcinogenic effects unless otherwise noted.

(C) = Screening concentration based on carcinogenic effects.

Shading indicates that the concentration exceeds the risk-based screening concentration for a child trespasser.

NA = No toxicity information available to calculate a risk-based screening concentration.

U = Analyte was not detected. The result of the analyte is less than the instrument detection limit. See Table 3-3.

TABLE 5-5
COMPARISON OF MAXIMUM TPL METAL CONCENTRATIONS FROM SOUTH DITCH UNNATURAL SEDIMENT WITH TACAO TIER I SOIL REMEDIATION OBJECTIVES FOR THE CONSTRUCTION WORKER SCENARIO

Compound	Maximum South Ditch Concentration[1] (0 to 6 inches) mg/kg	Maximum South Ditch Concentration[1] (All samples) mg/kg	Ingestion[2] mg/kg	Inhalation[2] mg/kg	Frequency of Exceedance South Ditch (0 to 6 in.)	Frequency of Exceedance South Ditch (All samples)
Arsenic	28.4	82.0	61	25,000	0/13	2/49
Beryllium	2.8 U	2.8 U	29	44,000	0/13	0/49
Cadmium	845	910	200	59,000	13/13	29/49
Chromium	25.7	78.2	4,100[3]	8,800[3]	0/13	0/49
Cobalt	66.2	70.2	12,000	NA	0/13	0/49
Copper	97,700	97,700	8,200	NA	13/13	26/49
Lead	1,740	3,440	400	NA	10/13	28/49
Manganese	3,080	6,730	10,000	8,700	0/13	0/49
Mercury	1.4 U	4.6	61	52,000	0/13	0/49
Nickel	69.4 U	69.4 U	4,100	440,000	0/13	0/49
Selenium	2.8 U	4.6	1,000	NA	0/13	0/49
Silver	144	144	1,000	NA	0/13	0/49
Vanadium	21.2	38.0	1,400	NA	0/13	0/49
Zinc	204,000	204,000	61,000	NA	13/13	26/49

[1] Metal concentrations reported on a dry weight basis.

[2] TACAO Tier I Soil Remediation Objectives for a construction worker.

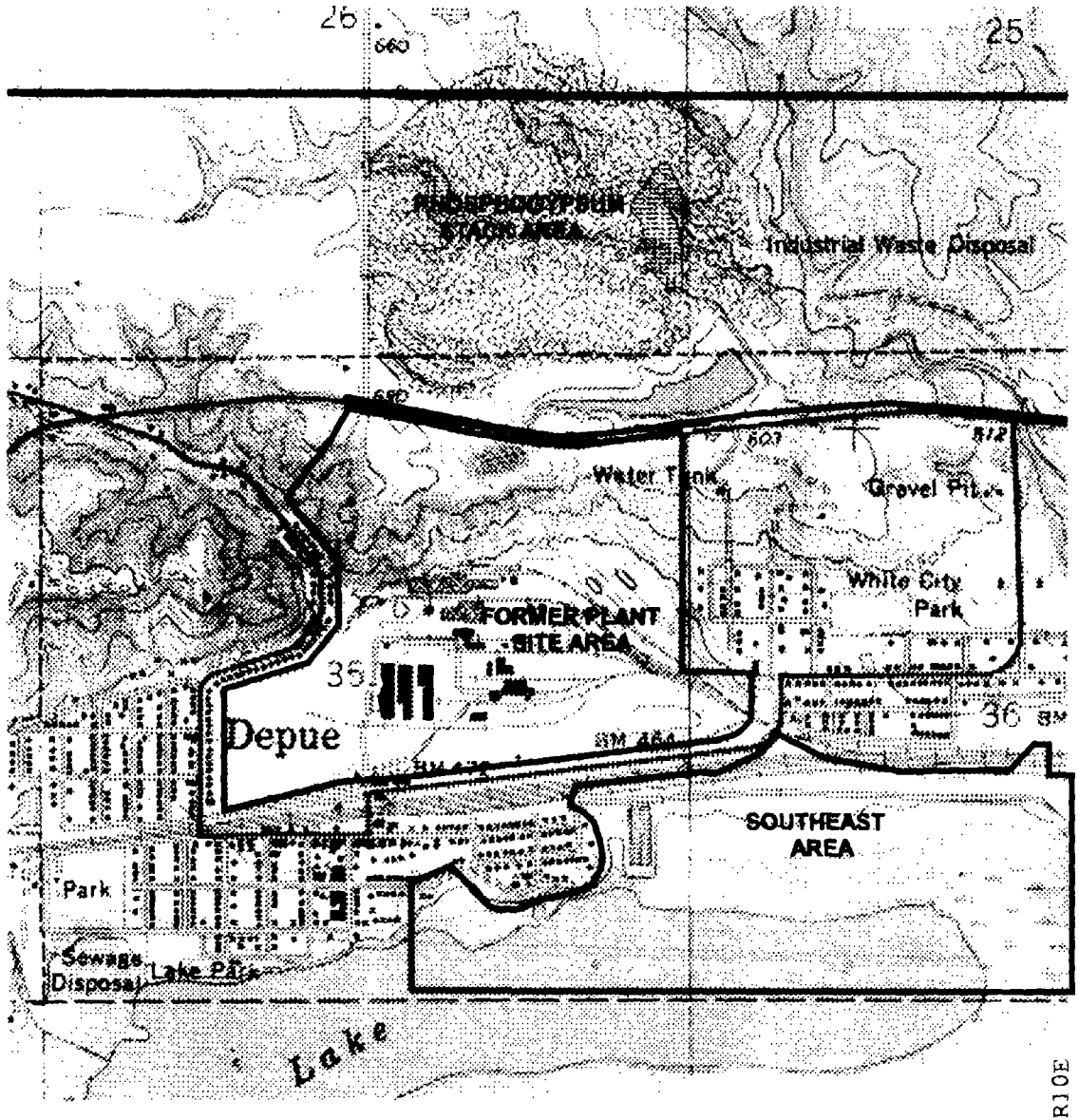
[3] Concentrations are for total chromium. Soil ingestion remediation objective for trivalent and hexavalent ions are 330,000 mg/kg and 4,100 mg/kg, respectively. No toxicty value is available for soil inhalation for trivalent chromium ion. The soil inhalation remediation objective for hexavalent chromium ion is 8,800 mg/kg.

Shading indicates that the concentration exceeds a TACAO Tier I Soil Remediation Objective for construction workers.

NA = No toxicity information available to establish a soil remediation objective.

U = Analyte was not detected. The result of the analyte is less than the instrument detection limit. See Table 3-5.

Figures



VICINITY MAP

SOURCE: U.S.G.S. 7.5 MINUTE QUADRANGLE MAPS DEPUE, ILL., 1966, PHOTOREVISED 1979.

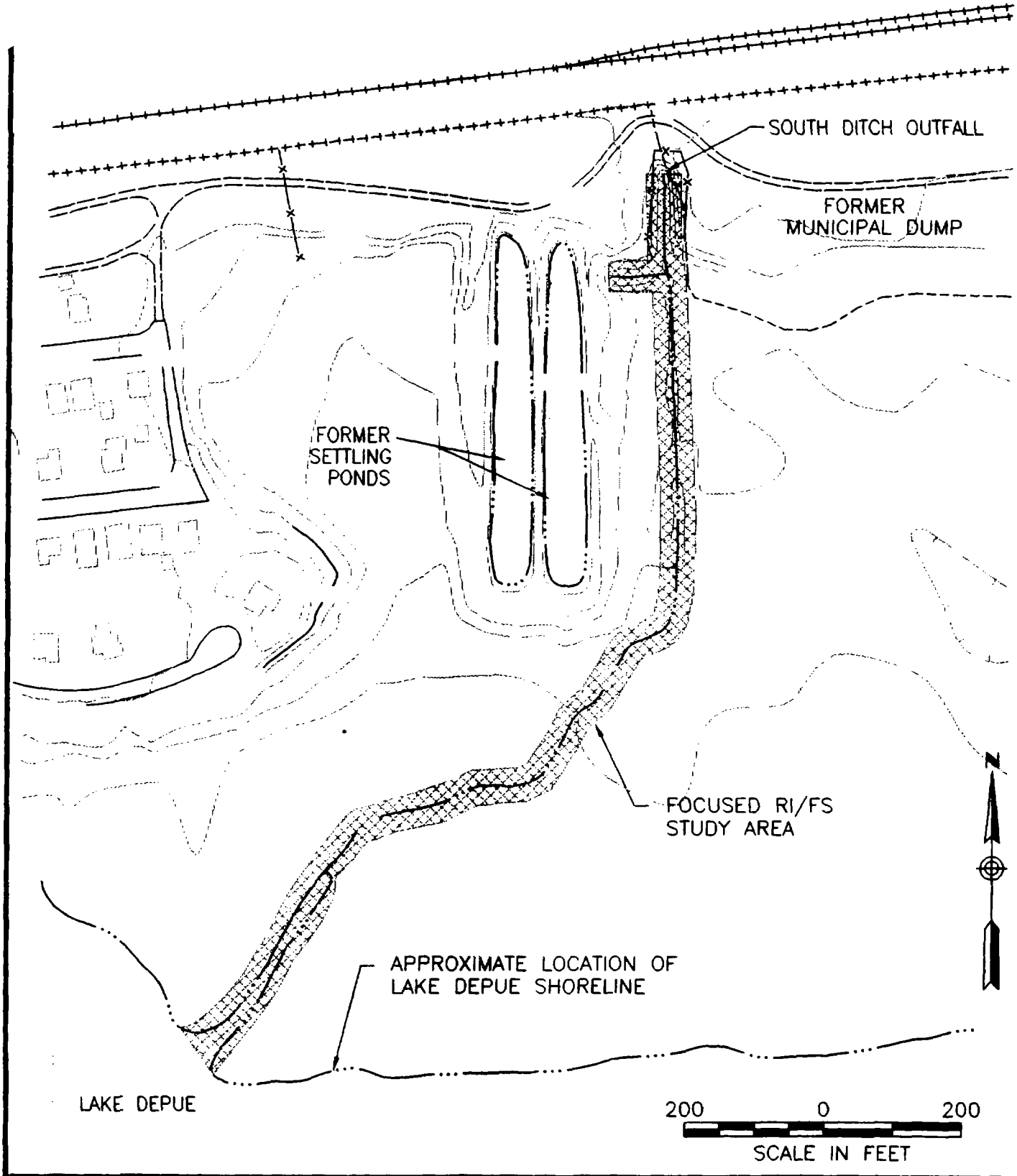
NOTE: CERTAIN BUILDINGS SHOWN IN FORMER PLANT SITE AREA HAVE BEEN PREVIOUSLY REMOVED.

SITE PLAN

1/4 0 1/4

SCALE IN MILES

CLIENT/PROJECT						TITLE		
DEPUE GROUP RI/FS			Golder Associates Chicago, Illinois			SITE LOCATION		
DRAWN	CHECKED	REVIEWED	DATE	SCALE	FILE NAME	JOB NO.	DWG NO.	FIGURE
NAP			12-2-95	AS SHOWN	DEPUE2b	953-8222		1-1



Golder Associates Chicago, Illinois

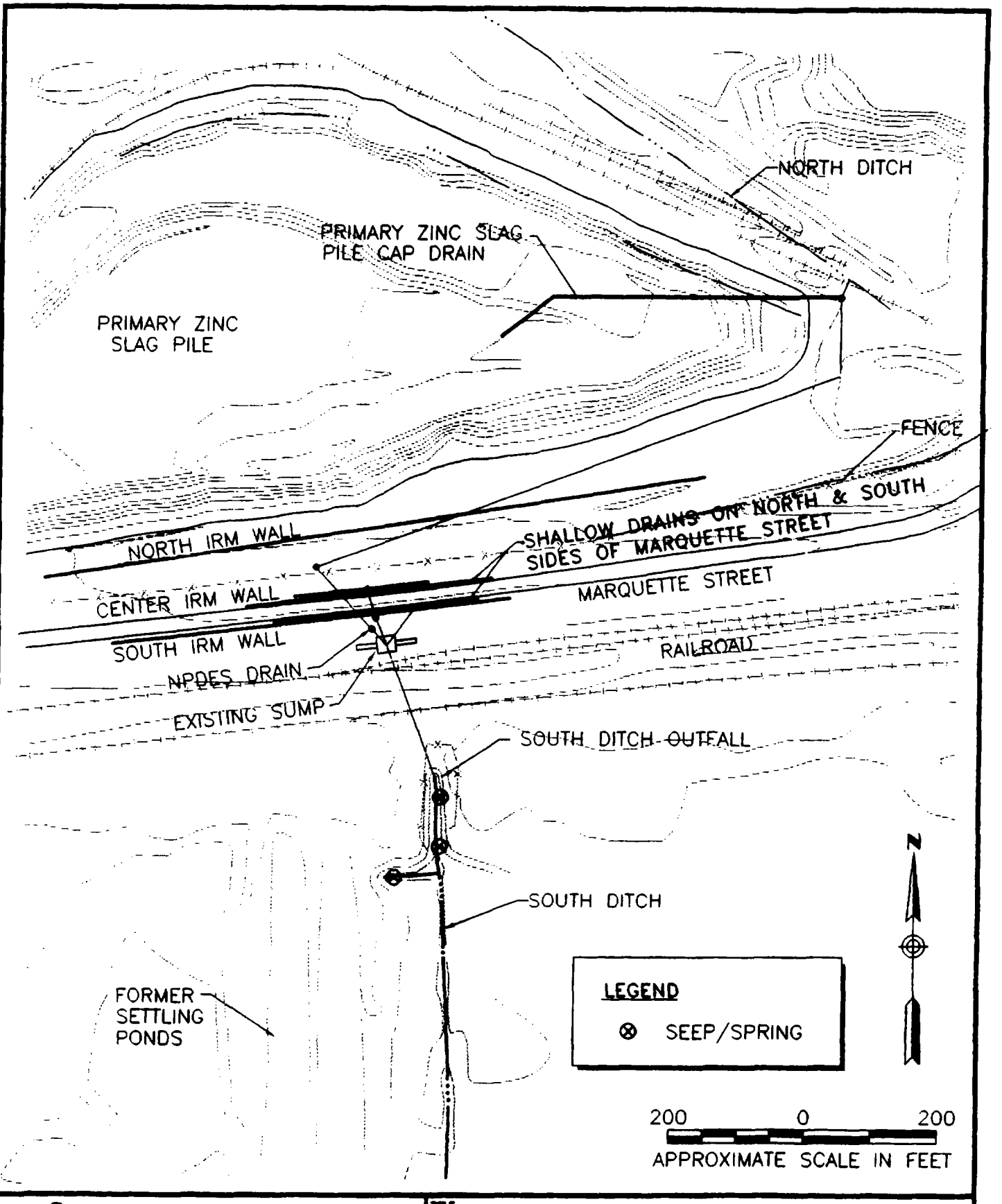
TITLE

STUDY AREA

CLIENT/PROJECT

DEPUE GROUP RI/FS

DRAWN	CCD	DATE	7/10/96	JOB NO.	953-8222
CHECKED		SCALE	AS SHOWN	DWG NO.	
REVIEWED		FILE NAME	8222132	FIGURE NO.	1-2

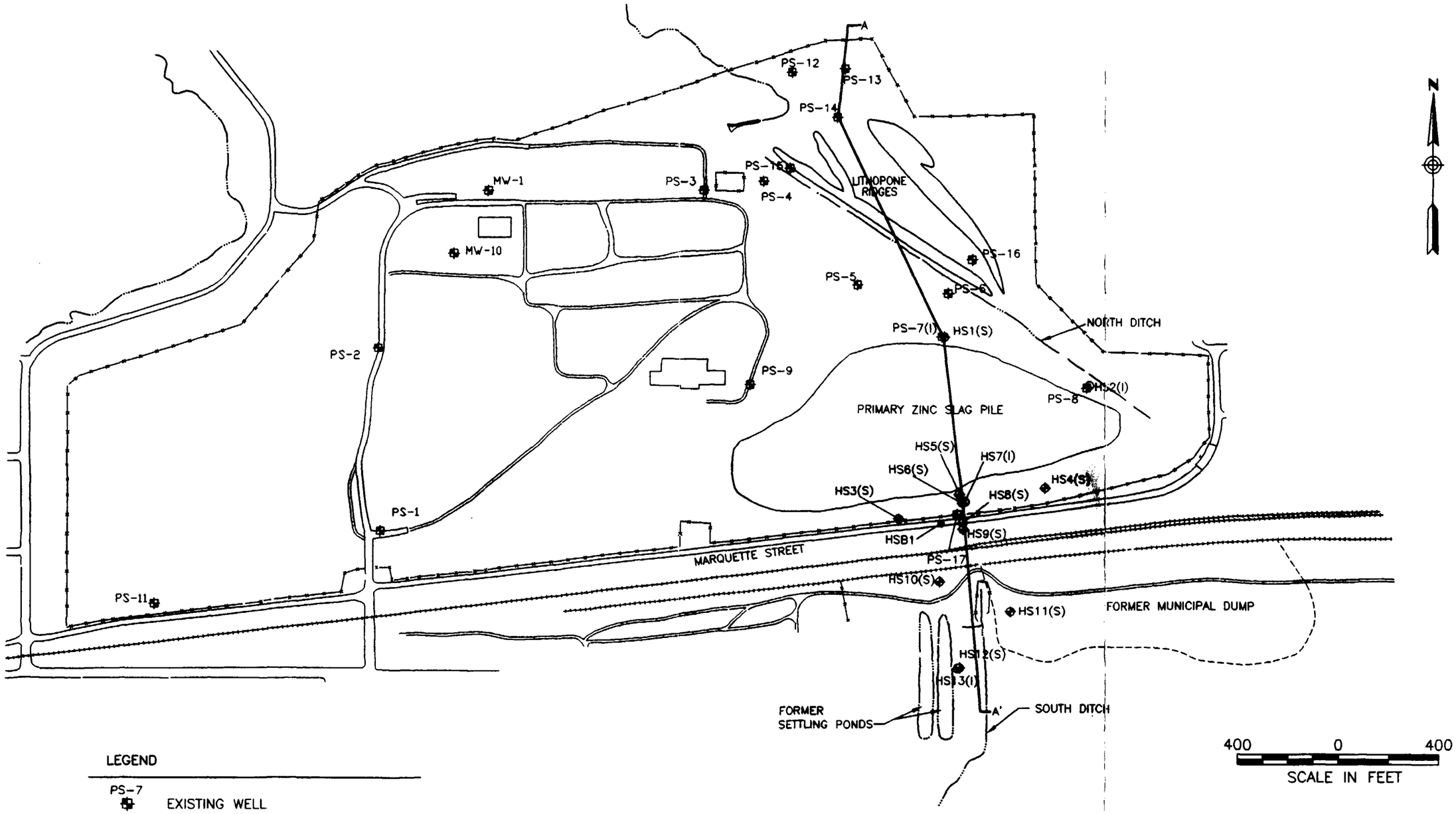


Golder Associates Chicago, Illinois

TITLE: **INFLUENT FLOW COMPONENTS TO SOUTH DITCH**

CLIENT/PROJECT: **DEPUE GROUP RI/FS**

DRAWN	NAP	DATE	1/21/97	JOB NO.	953-8222
CHECKED		SCALE	AS SHOWN	DWG NO.	
REVIEWED		FILE NAME	8222218	FIGURE NO.	1-3



LEGEND

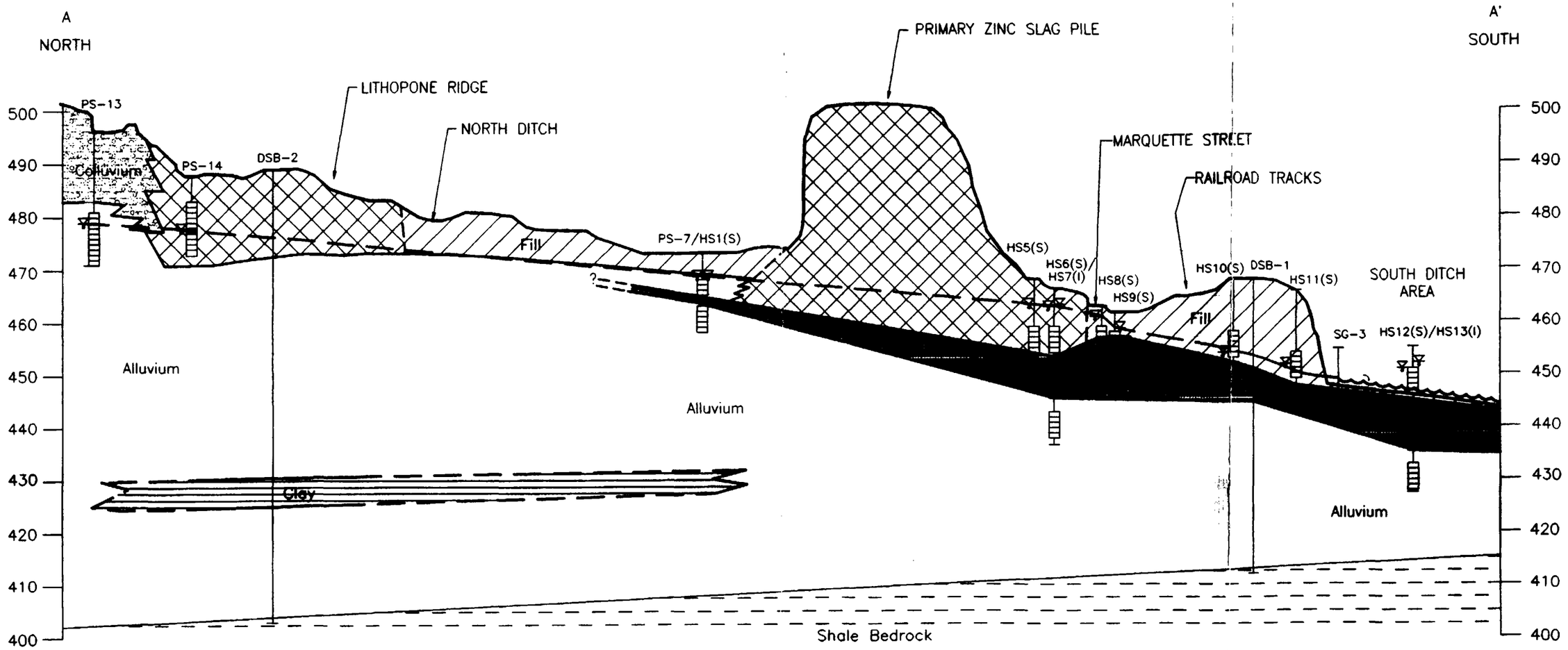
PS-7	EXISTING WELL
HS1(S)	NEW SHALLOW WELL
HS13(I)	NEW INTERMEDIATE WELL
HSB1	APPROXIMATE LOCATION OF MARQUETTE STREET SOIL BORING
A – A'	LOCATION OF NORTH–SOUTH CROSS–SECTION (A – A')

Golder Associates Chicago, Illinois

CLIENT/PROJECT
DEPUE GROUP RI/FS

TITLE
PIEZOMETER AND WELL LOCATIONS

DRAWN NAP	DATE 8/8/96	JOB NO. 953-8222	
CHECKED	SCALE AS SHOWN	DWG. NO.	
REVIEWED	FILE NAME 8222177	FIGURE NO. 1-4	



LEGEND

- FILL
- ALLUVIUM
- PEAT
- COLLUVIUM
- CLAY
- LITHOPONE OR PRIMARY ZINC SLAG PILE RESIDUE
- SHALE BEDROCK
- GROUNDWATER ELEVATION (8/17/95)
- SHALLOW WATER TABLE

NOTE:

1. DATA FROM THE FOLLOWING BOREHOLES/WELLS ARE PROJECTED ONTO THE CROSS-SECTION: DSB-1, DSB-2, HS10(S), HS11(S) HS12(S) AND HS13(I).
2. STRATIGRAPHY IS KNOWN OR INFERRED AT WELL LOCATIONS ONLY. STRATIGRAPHY BETWEEN WELL LOCATIONS IS INTERPOLATED, AND ACTUAL STRATIGRAPHY MAY VARY SUBSTANTIALLY FROM THAT WHICH IS SHOWN.

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 20'
VERTICAL EXAGGERATION: 10X

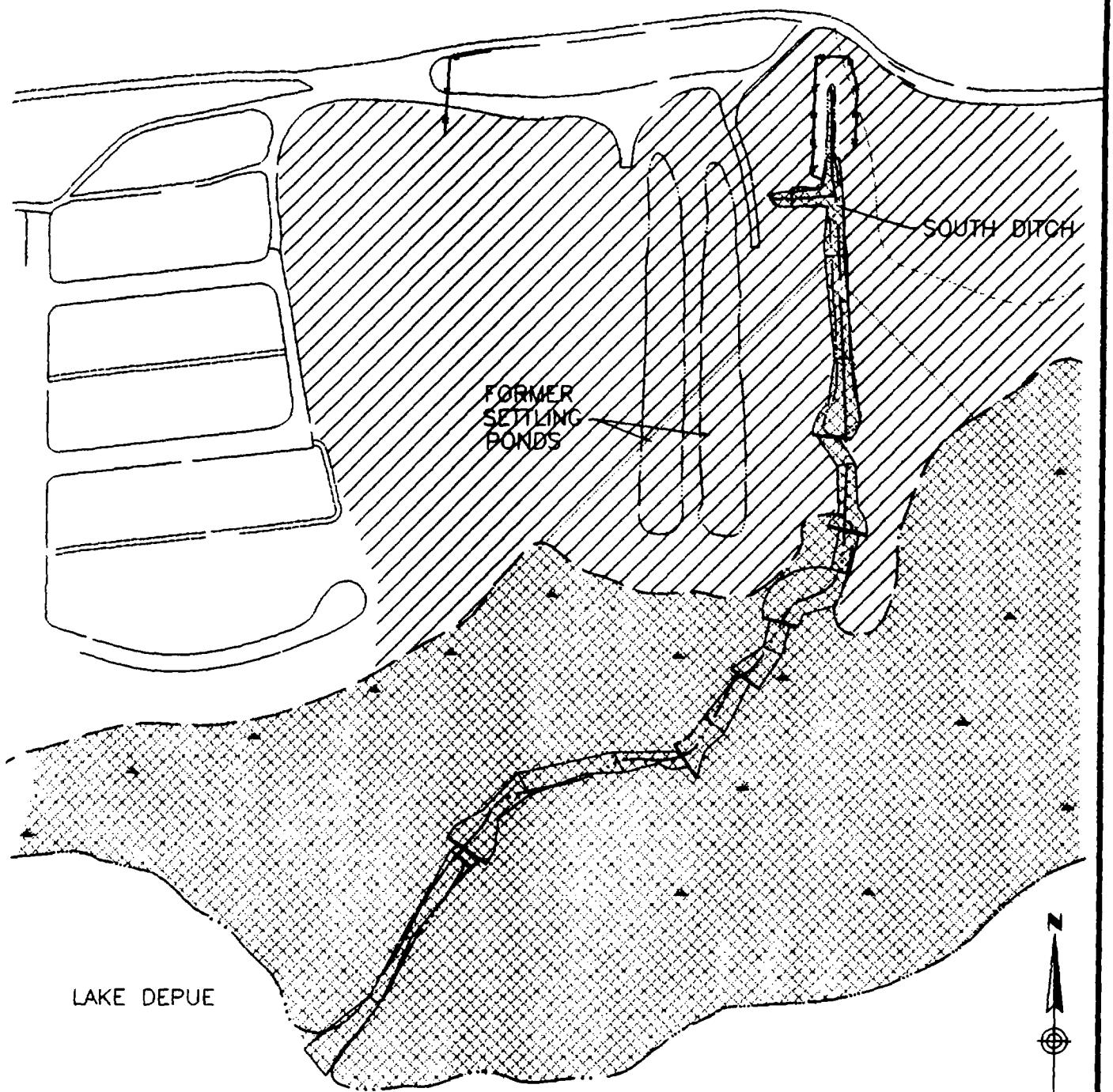
200 0 200
SCALE IN FEET

Golder Associates Chicago, Illinois

CLIENT/PROJECT
DEPUE GROUP RI/FS

TITLE
NORTH-SOUTH (A-A') CROSS-SECTION

DRAWN	NAP	DATE 11/28/95	JOB NO. 953-8222
CHECKED		SCALE AS SHOWN	DWG. NO.
REVIEWED		FILE NAME 8222147	FIGURE NO. 1-5



LEGEND

SHALLOW GROUNDWATER SYSTEM AND ALLUVIAL AQUIFER

THIN VENEER OF SHALLOW GROUNDWATER SYSTEM AND ALLUVIAL AQUIFER

200 0 200

SCALE IN FEET

Golder Associates Chicago, Illinois

TITLE: DISTRIBUTION OF GROUNDWATER-BEARING UNITS IN SOUTHEAST AREA

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	2/12/97	JOB NO.	953-8222
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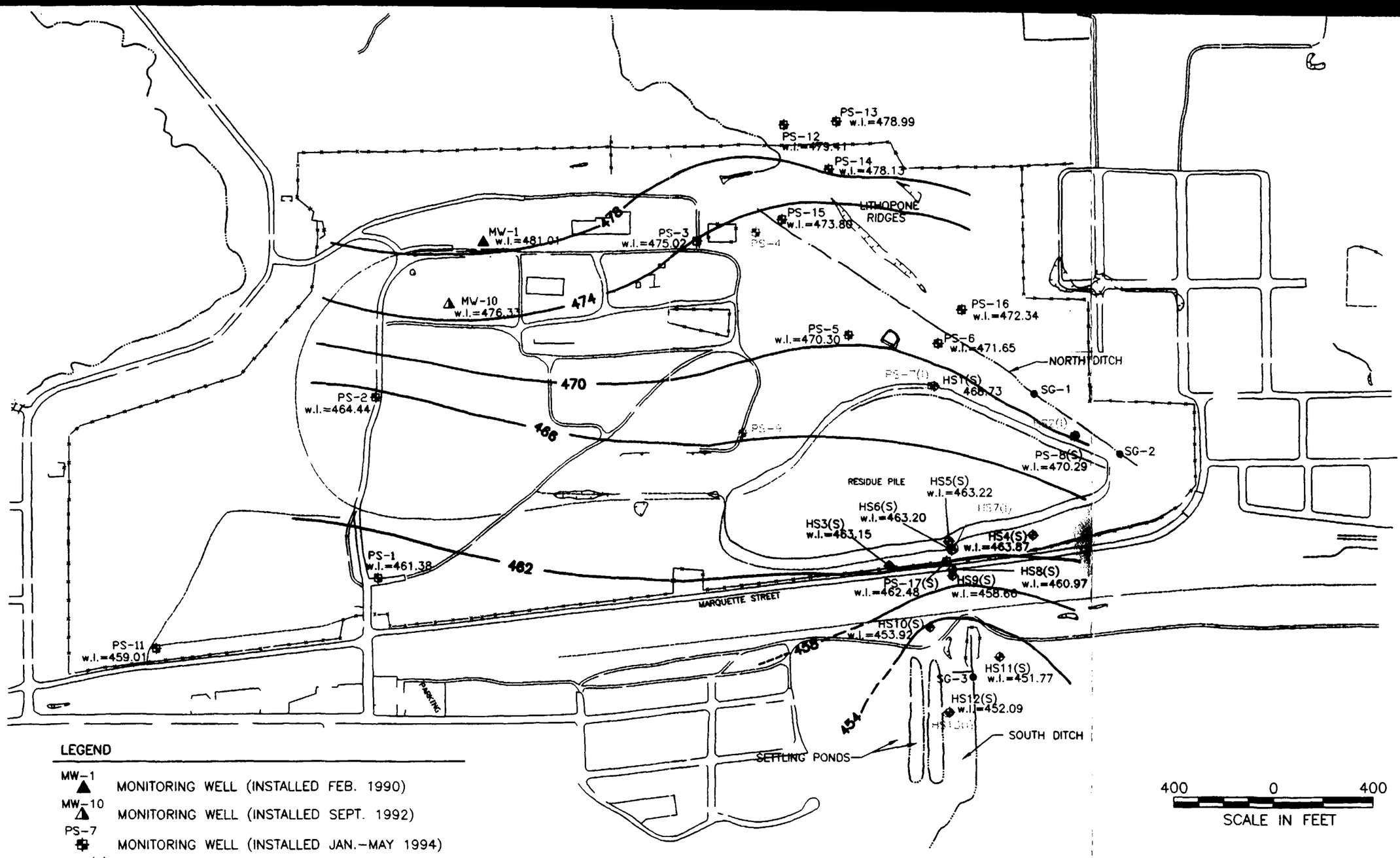


LEGEND

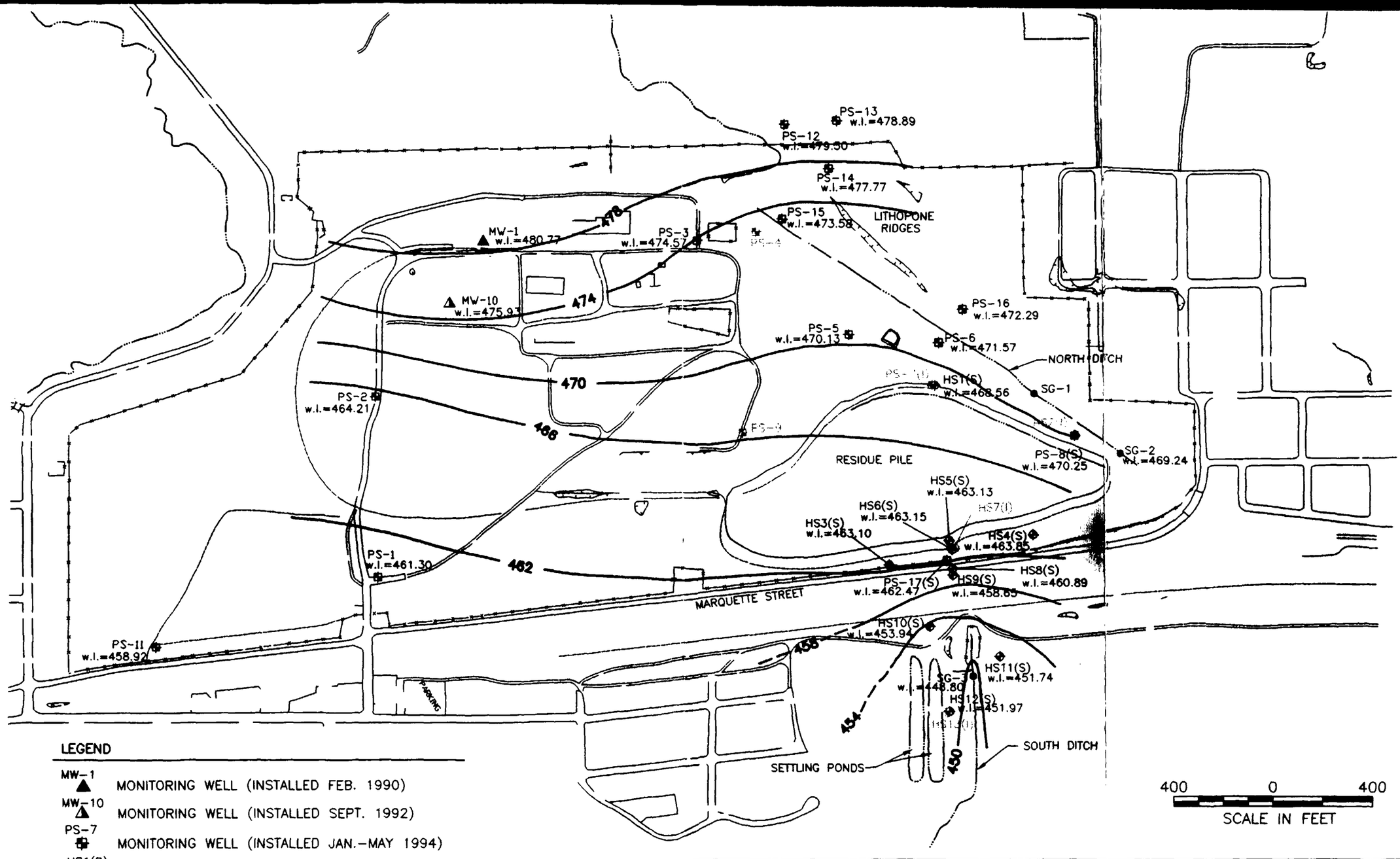
- MW-1 — MONITORING WELL (INSTALLED FEB. 1990)
- MW-10 — MONITORING WELL (INSTALLED SEPT. 1992)
- PS-7 — MONITORING WELL (INSTALLED JAN.–MAY 1994)
- HS1(S) — SHALLOW AQUIFER MONITORING WELL (INSTALLED JULY 1995)
- HS13(I) — INTERMEDIATE AQUIFER WELL (INSTALLED JULY 1995)
- SG-1 — STAFF GAUGE
- w.l.=471.65 — SHALLOW GROUNDWATER ELEVATION (FT. MSL)
- 470 — GROUNDWATER ELEVATION CONTOUR

Golder Associates — Chicago, Illinois

CLIENT/PROJECT: DEPUE/RI-FS/IL

TITLE: SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE – AUGUST 1, 1995

DRAWN: NAP	DATE: 8/15/95	JOB NO.: 953-8222
CHECKED:	SCALE: AS SHOWN	DWG. NO.:
REVIEWED:	FILE NAME: 8222117	FIGURE NO.: 1-7



LEGEND

- MW-1 ▲ MONITORING WELL (INSTALLED FEB. 1990)
- MW-10 ▲ MONITORING WELL (INSTALLED SEPT. 1992)
- PS-7 ⊞ MONITORING WELL (INSTALLED JAN.–MAY 1994)
- HS1(S) ◈ SHALLOW AQUIFER MONITORING WELL (INSTALLED JULY 1995)
- HS13(I) ◉ INTERMEDIATE AQUIFER WELL (INSTALLED JULY 1995)
- SG-1 ● STAFF GAUGE
- w.l.=471.65 SHALLOW GROUNDWATER ELEVATION (FT. MSL)
- 470 GROUNDWATER ELEVATION CONTOUR

Golder Associates — Chicago, Illinois

CLIENT/PROJECT: DEPUE/RI–FS/IL

TITLE: SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE – AUGUST 17, 1995

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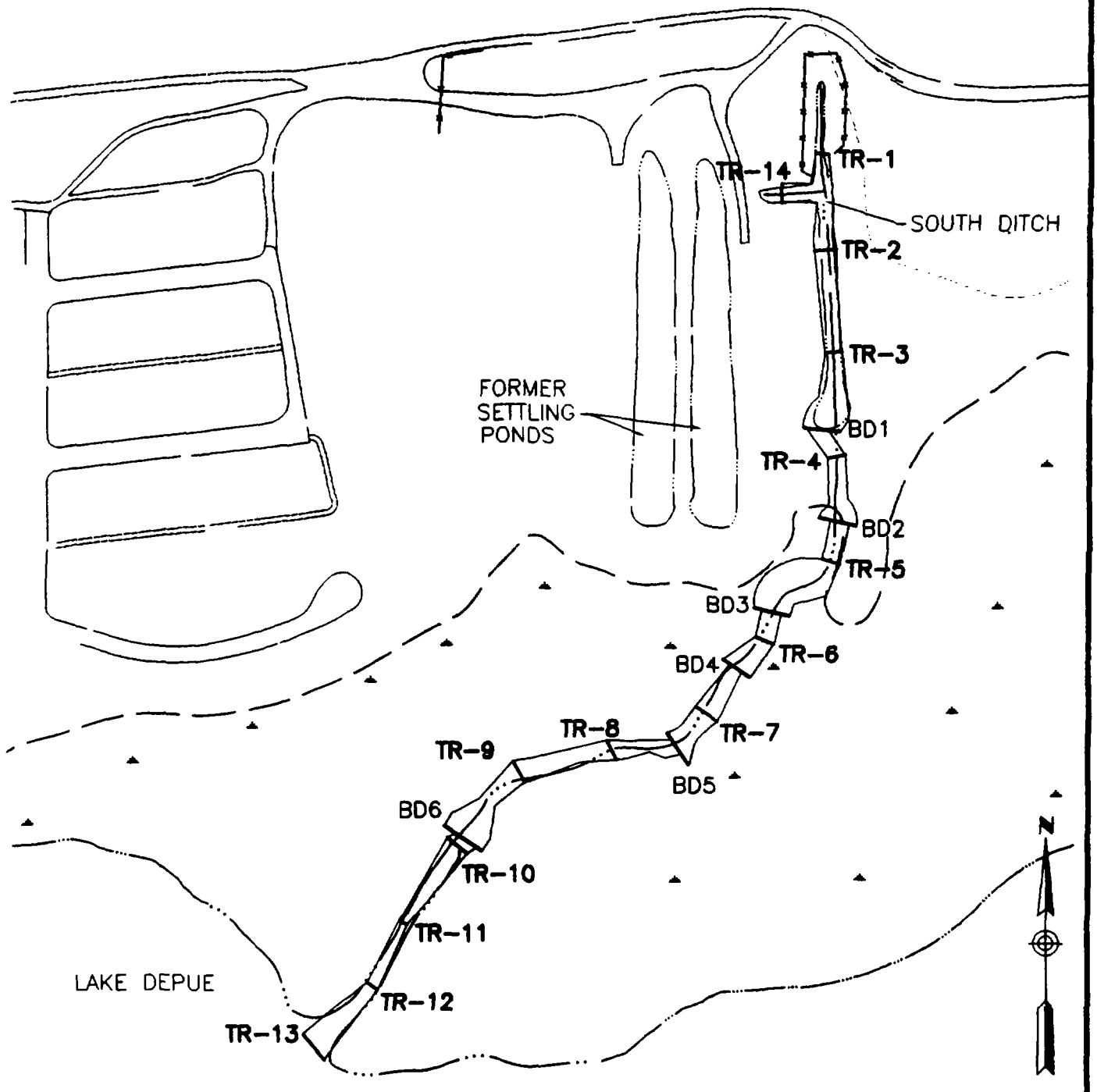

LEGEND

BD6 – BEAVER DAM 1

TR-13 – TRANSECT LOCATION

200 0 200

SCALE IN FEET

Golder Associates Chicago, Illinois

TITLE

TRANSECT LOCATIONS

CLIENT/PROJECT

DEPUE GROUP RI/FS

DRAWN	NAP	DATE	7/10/96	JOB NO.	953-8222
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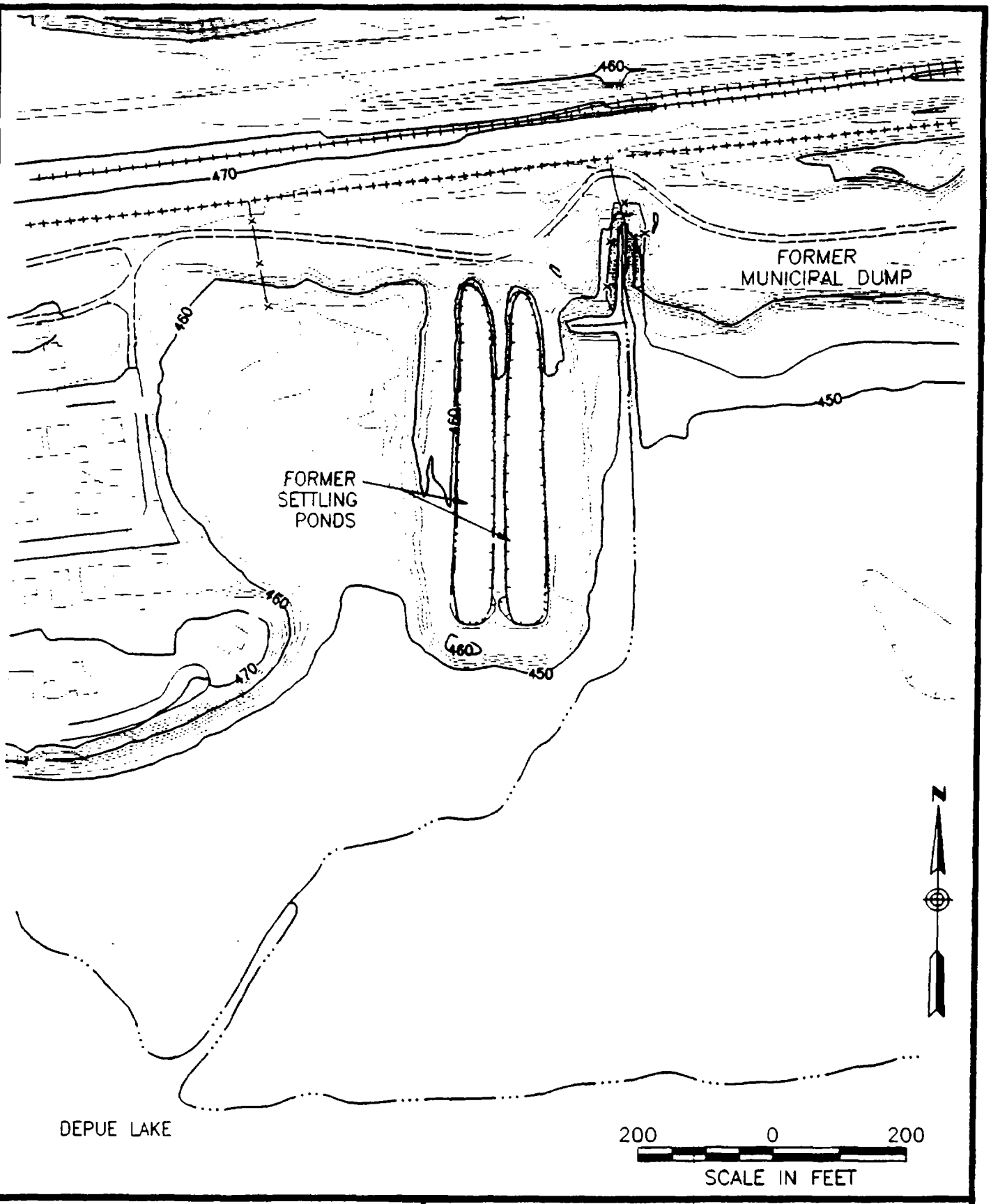

Golder Associates Chicago, Illinois

TITLE: TOPOGRAPHIC CONTOUR MAP OF THE SOUTH DITCH STUDY AREA

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	1/9/97	JOB NO.	953-8222
CHECKED		SCALE	AS SHOWN	DWG NO.	
REVIEWED		FILE NAME	8222215	FIGURE NO.	2-2

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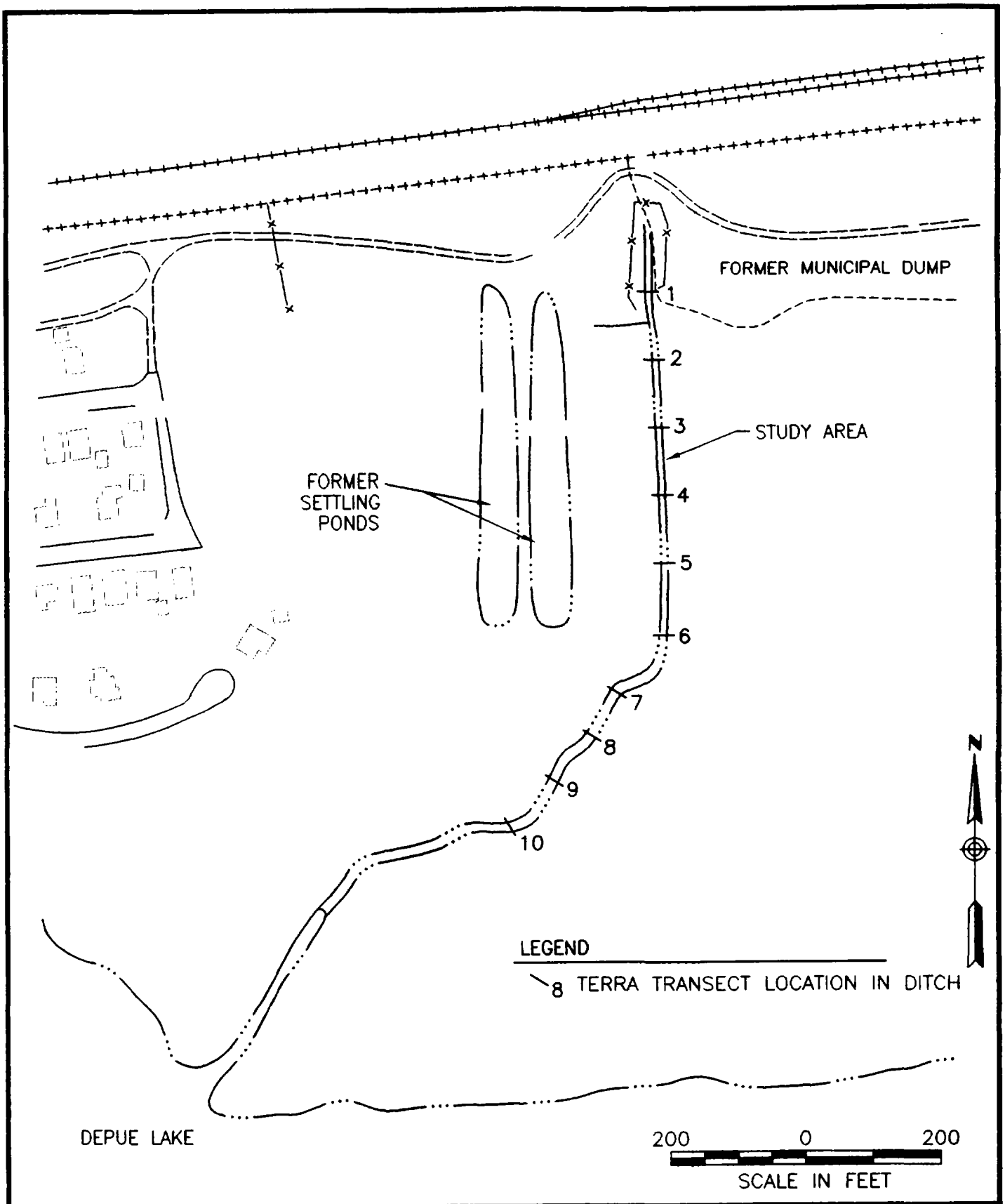

Golder Associates Chicago, Illinois

TITLE

TERRA TRANSECT LOCATIONS

CLIENT/PROJECT

DEPUE GROUP RI/FS

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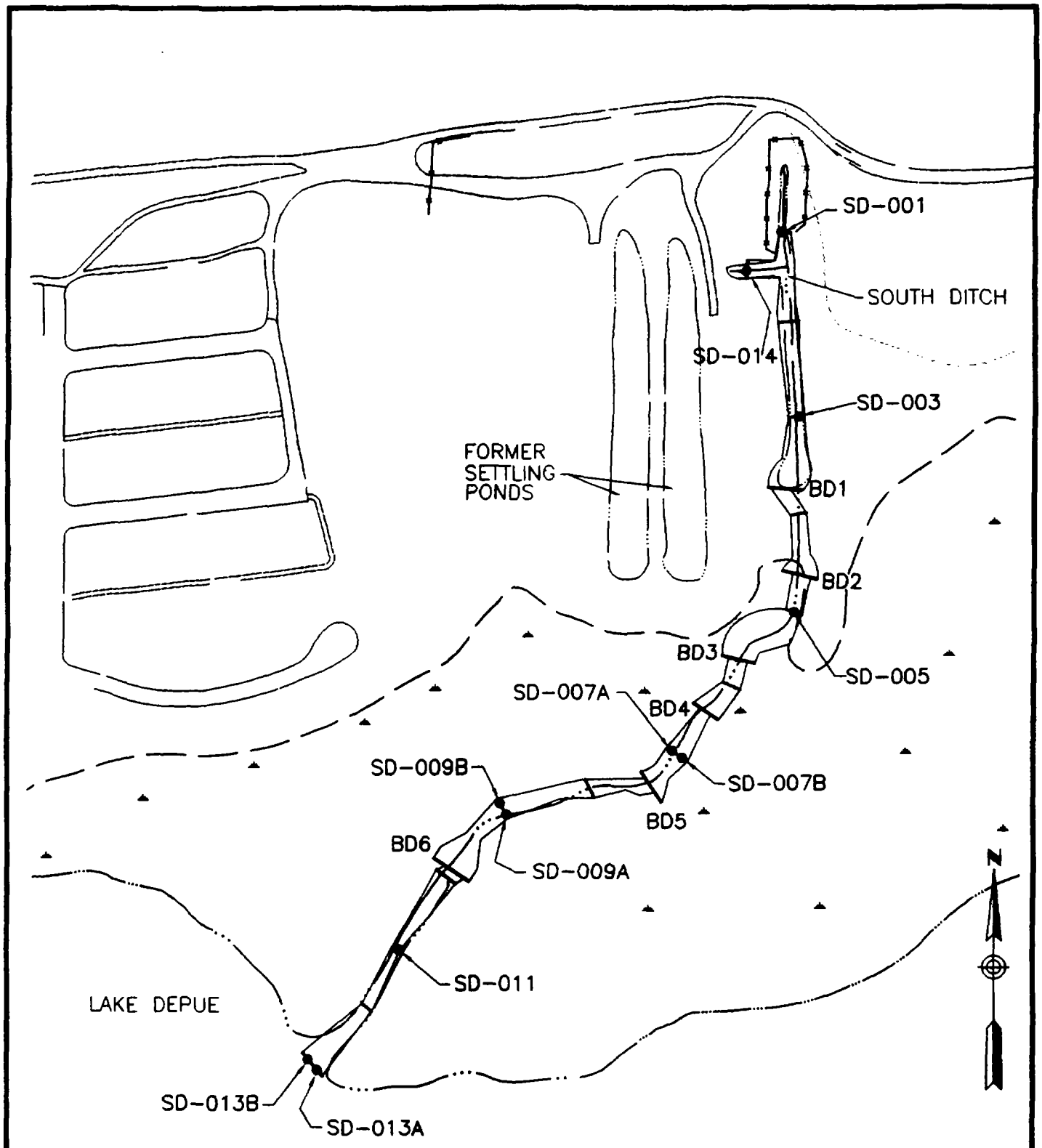

Golder Associates Chicago, Illinois

TITLE

UNNATURAL SEDIMENT SAMPLE LOCATIONS

CLIENT/PROJECT					
DEPUE GROUP RI/FS	DRAWN	NAP	DATE	7/10/96	JOB NO. 953-8222
	CHECKED		SCALE	AS SHOWN	DWG NO.
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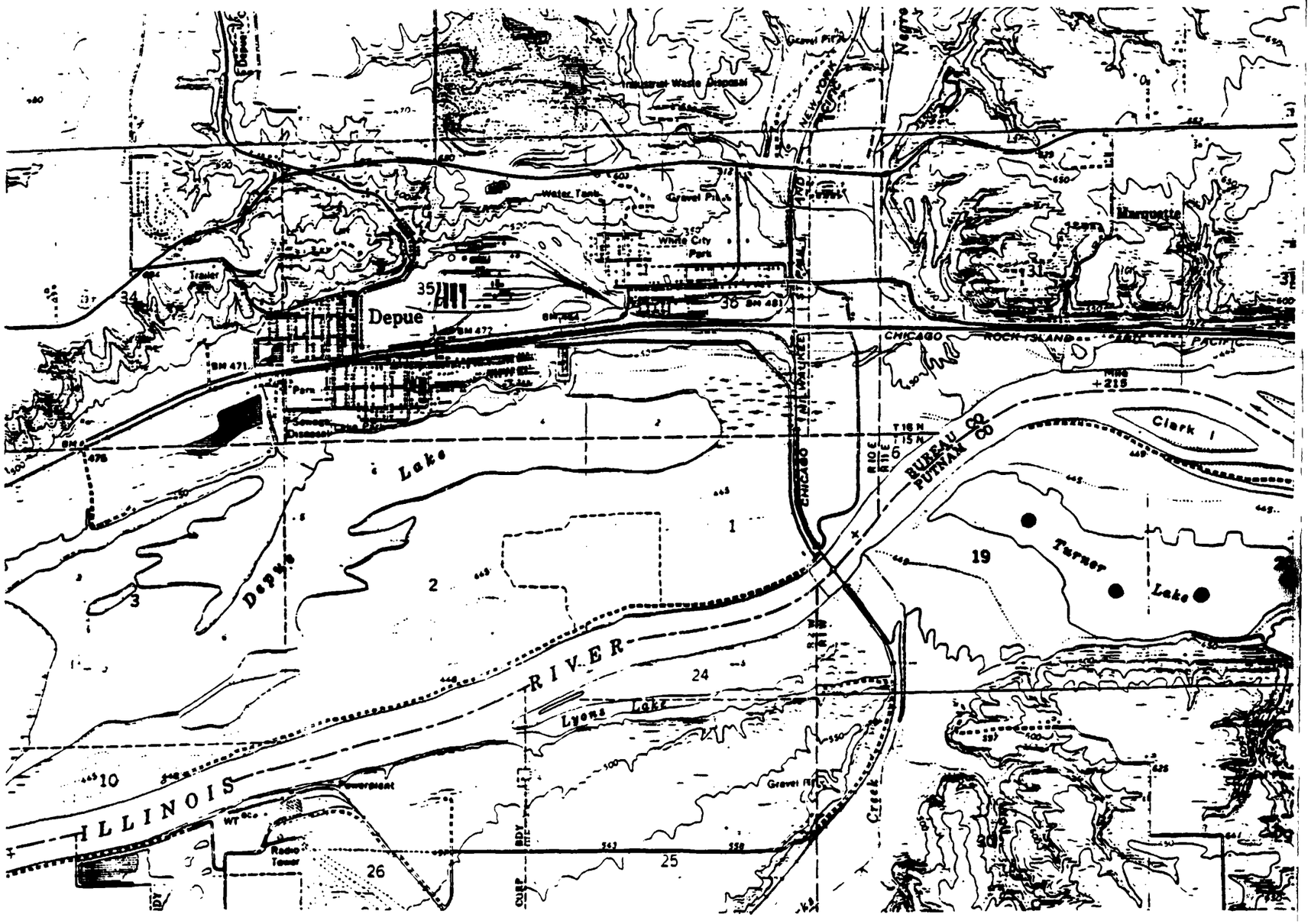


LEGEND

● APPROXIMATE BACKGROUND SEDIMENT SAMPLE LOCATIONS

N

2000 0 2000

SCALE IN FEET

Golder Associates Chicago, Illinois

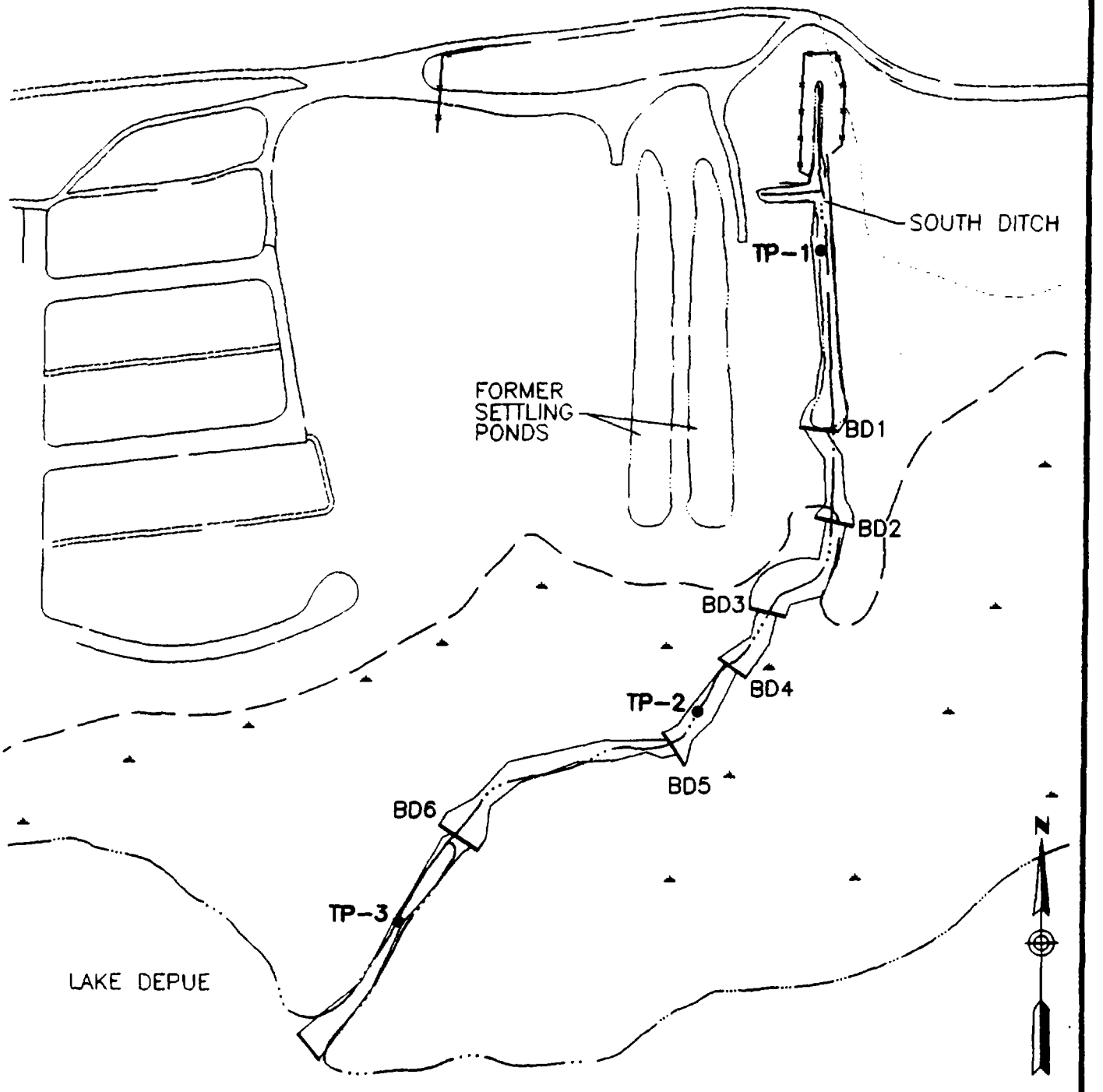
CLIENT/PROJECT

DEPUE GROUP RI/FS

TITLE

APPROXIMATE BACKGROUND SEDIMENT SAMPLE LOCATIONS

DRAWN NAP	DATE 10/6/95	JOB NO. 953-8222
CHECKED	SCALE AS SHOWN	DWG. NO.
REVIEWED	FILE NAME 8222140	FIGURE NO. 2-6



LEGEND

BD6 – BEAVER DAM 1

TP-3 ● – TEMPORARY PIEZOMETER LOCATION

200 0 200

SCALE IN FEET

Golder Associates Chicago, Illinois

TITLE

TEMPORARY PIEZOMETER LOCATIONS

CLIENT/PROJECT

DEPUE GROUP RI/FS

DRAWN	NAP	DATE	7/15/96	JOB NO.	953-8222
CHECKED		SCALE	AS SHOWN	DWG NO.	
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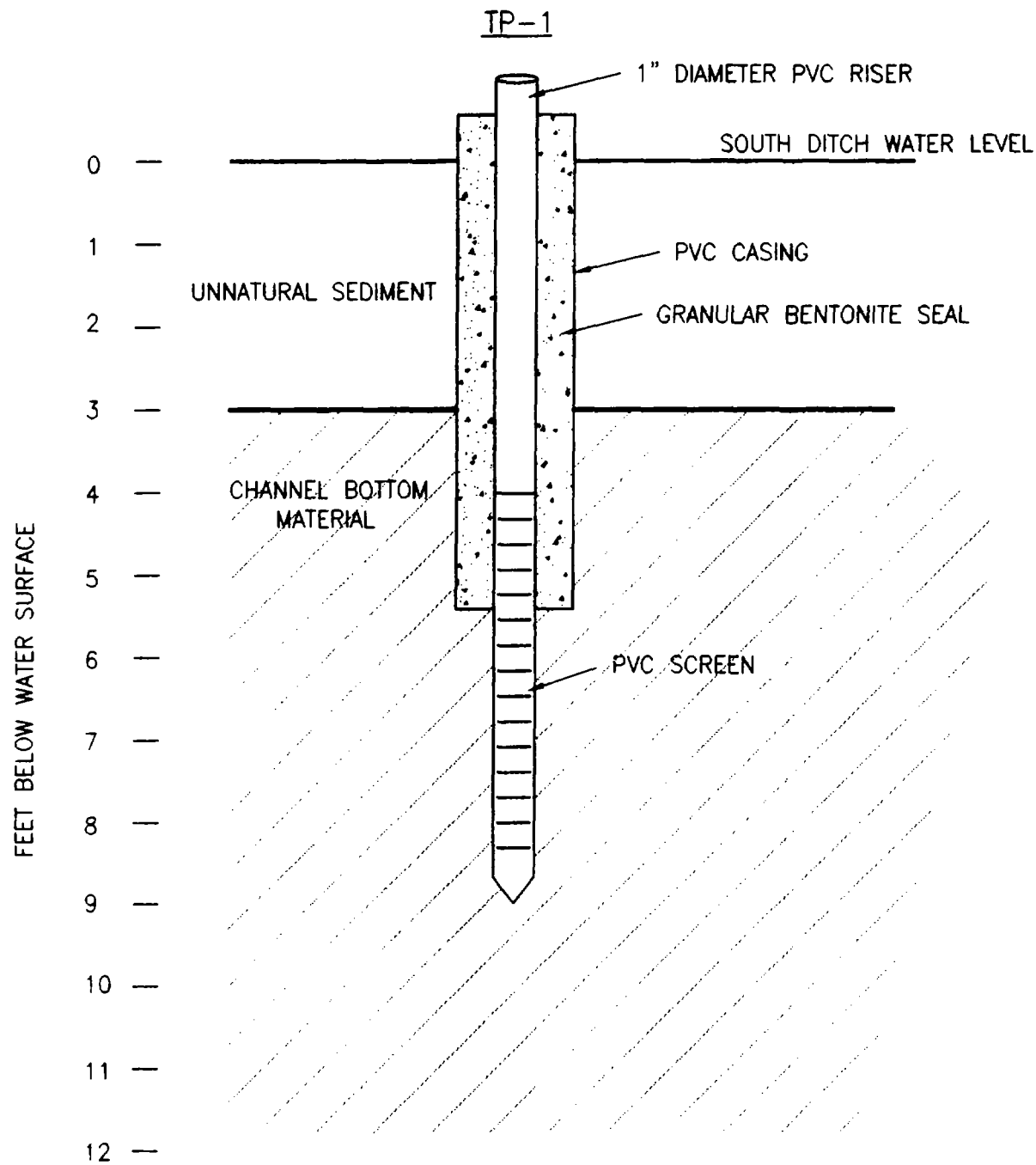

Golder Associates Chicago, Illinois

TITLE: TEMPORARY PIEZOMETER CONSTRUCTION DIAGRAM, TP-1

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	7/24/96	JOB NO.	953-8222
CHECKED		SCALE	NTS	DWG NO.	
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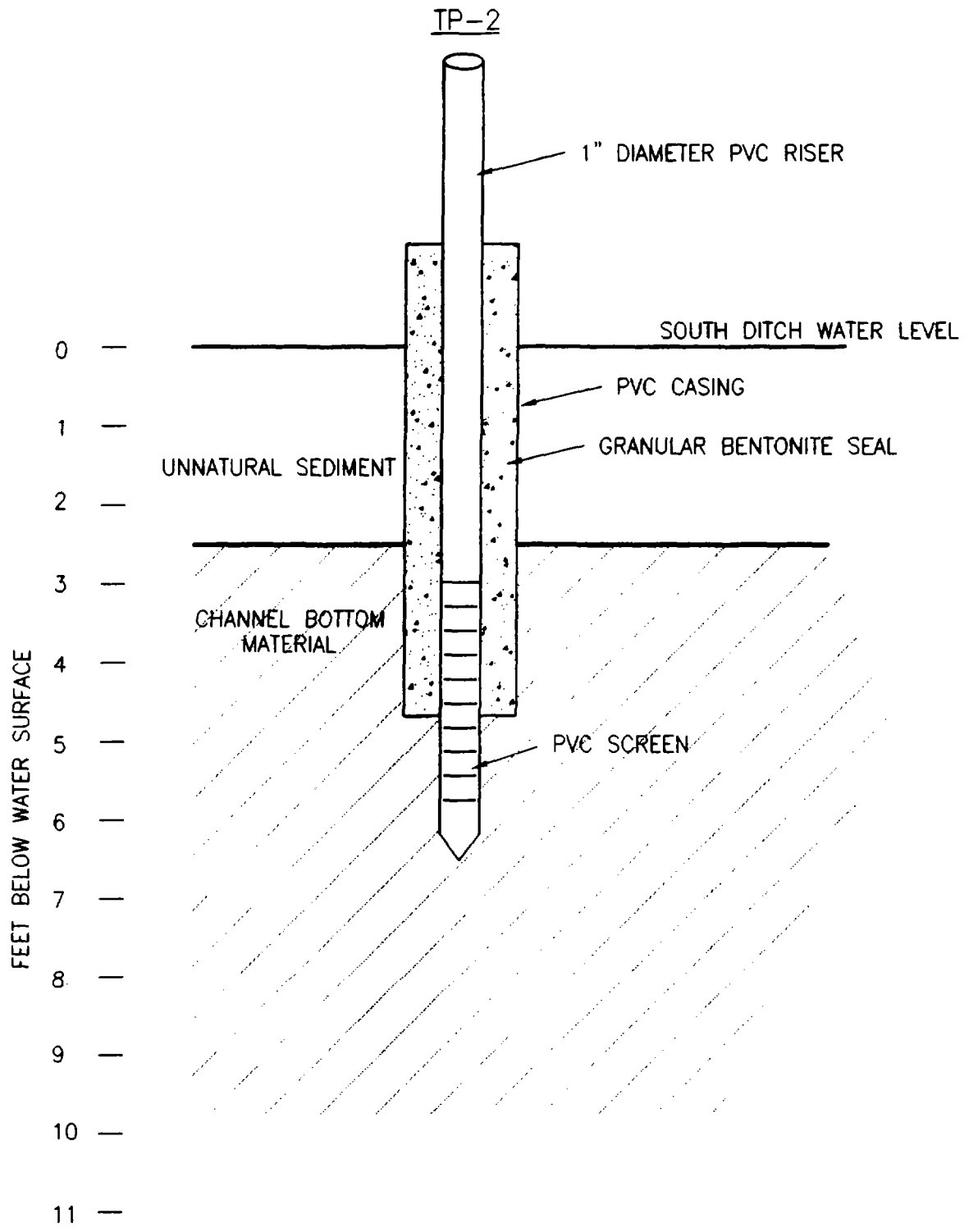

Golder Associates Chicago, Illinois

TITLE: TEMPORARY PIEZOMETER CONSTRUCTION DIAGRAM, TP-2

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	7/24/96	JOB NO.	953-8222
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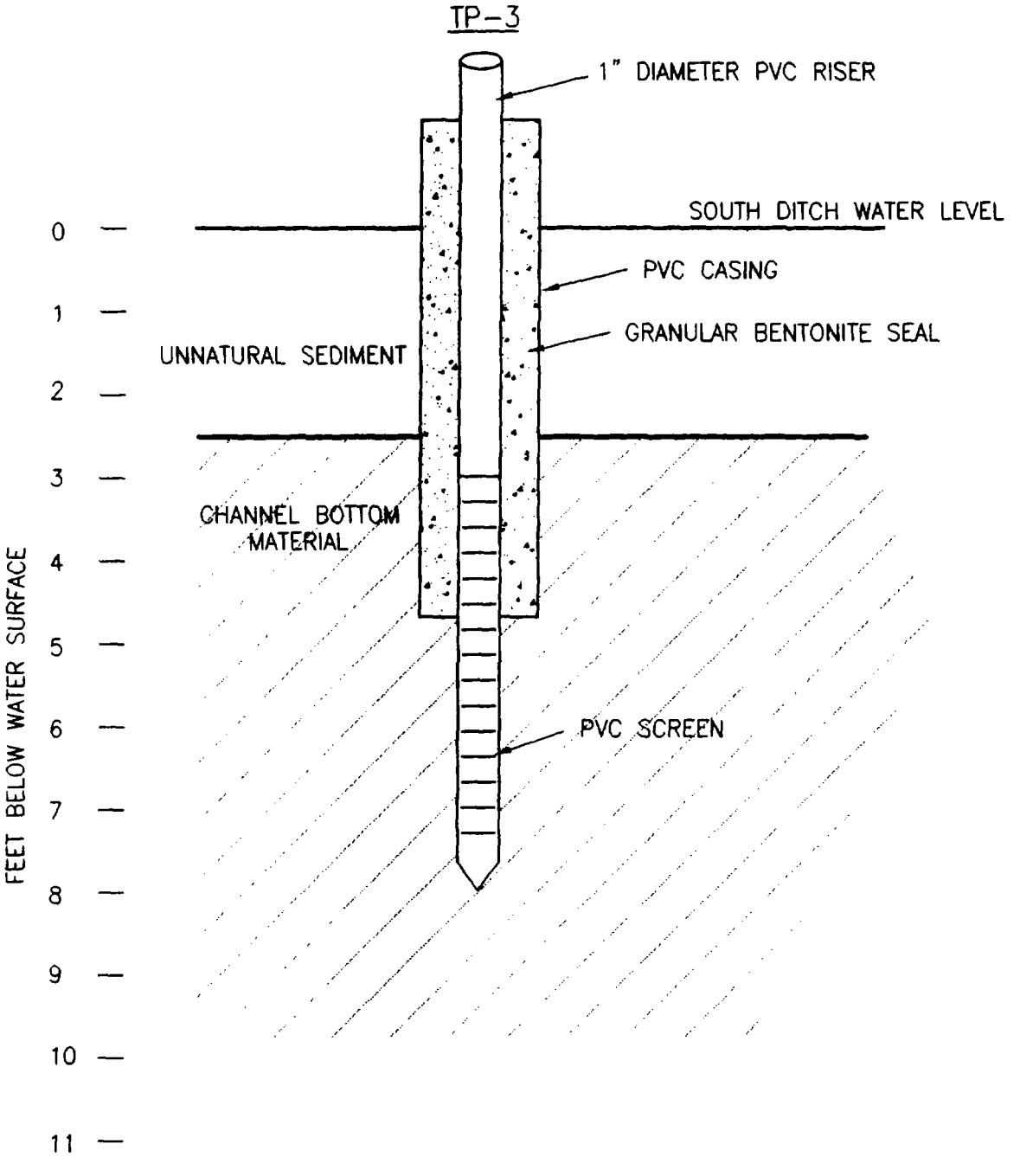

Golder Associates Chicago, Illinois

TITLE: TEMPORARY PIEZOMETER CONSTRUCTION DIAGRAM, TP-3

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	7/24/96	JOB NO.	953-8222
CHECKED		SCALE	NTS	DWG NO.	
REVIEWED		FILE NAME	8222172	FIGURE NO.	2-10

Golder Associates Chicago, Illinois

TITLE: 1992 AERIAL PHOTOGRAPH OF THE SOUTH DITCH

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	10/28/96	JOB NO.	953-8222
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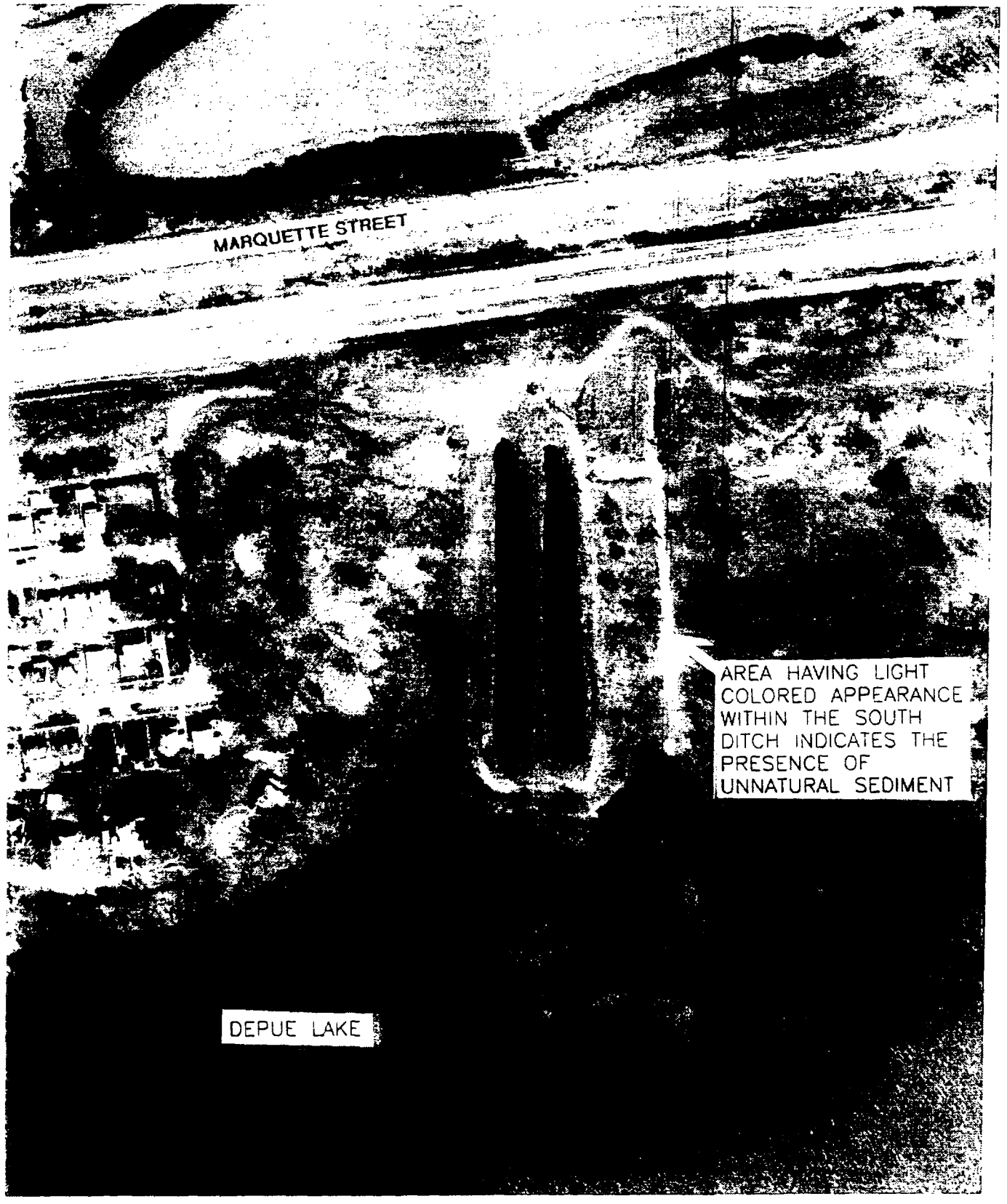

Golder Associates Chicago, Illinois

TITLE: 1995 AERIAL PHOTOGRAPH OF THE SOUTH DITCH

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	1/9/97	JOB NO.	953-8222
CHECKED		SCALE	1 = 200'	DWG NO.	
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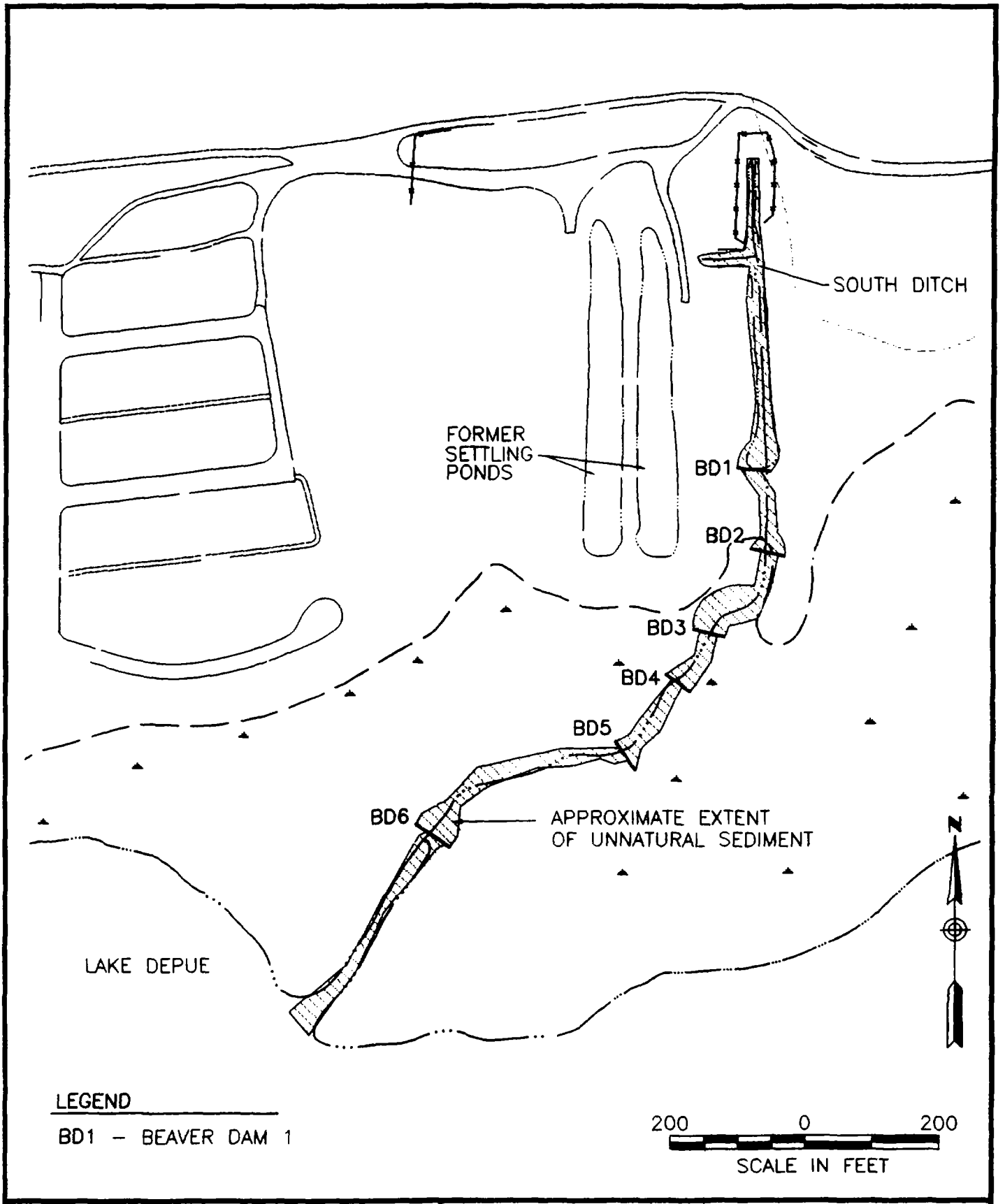


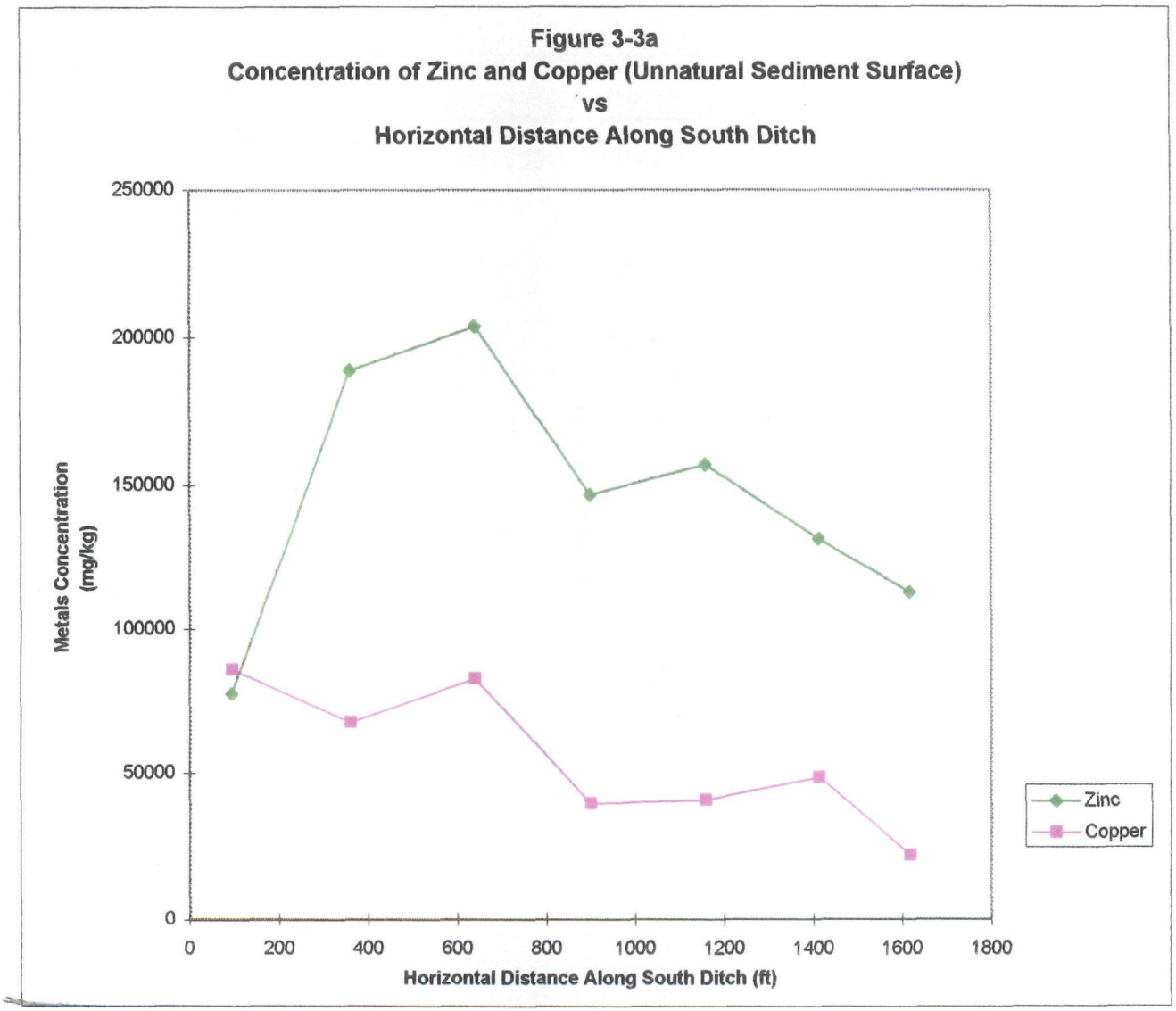
Golder Associates Chicago, Illinois

TITLE: APPROXIMATE EXTENT OF UNNATURAL SEDIMENT

CLIENT/PROJECT: DEPUE GROUP RI/FS

DRAWN	NAP	DATE	3/21/97	JOB NO.	953-8222
CHECKED		SCALE	AS SHOWN	DWG NO.	
REVIEWED		FILE NAME	8222170	FIGURE NO.	3-2

Figure 3-3a
Concentration of Zinc and Copper (Unnatural Sediment Surface)
vs
Horizontal Distance Along South Ditch



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Golder Associates

Figure 3-3b
Concentration of Zinc and Copper (2nd Depth Interval)
vs
Horizontal Distance Along South Ditch

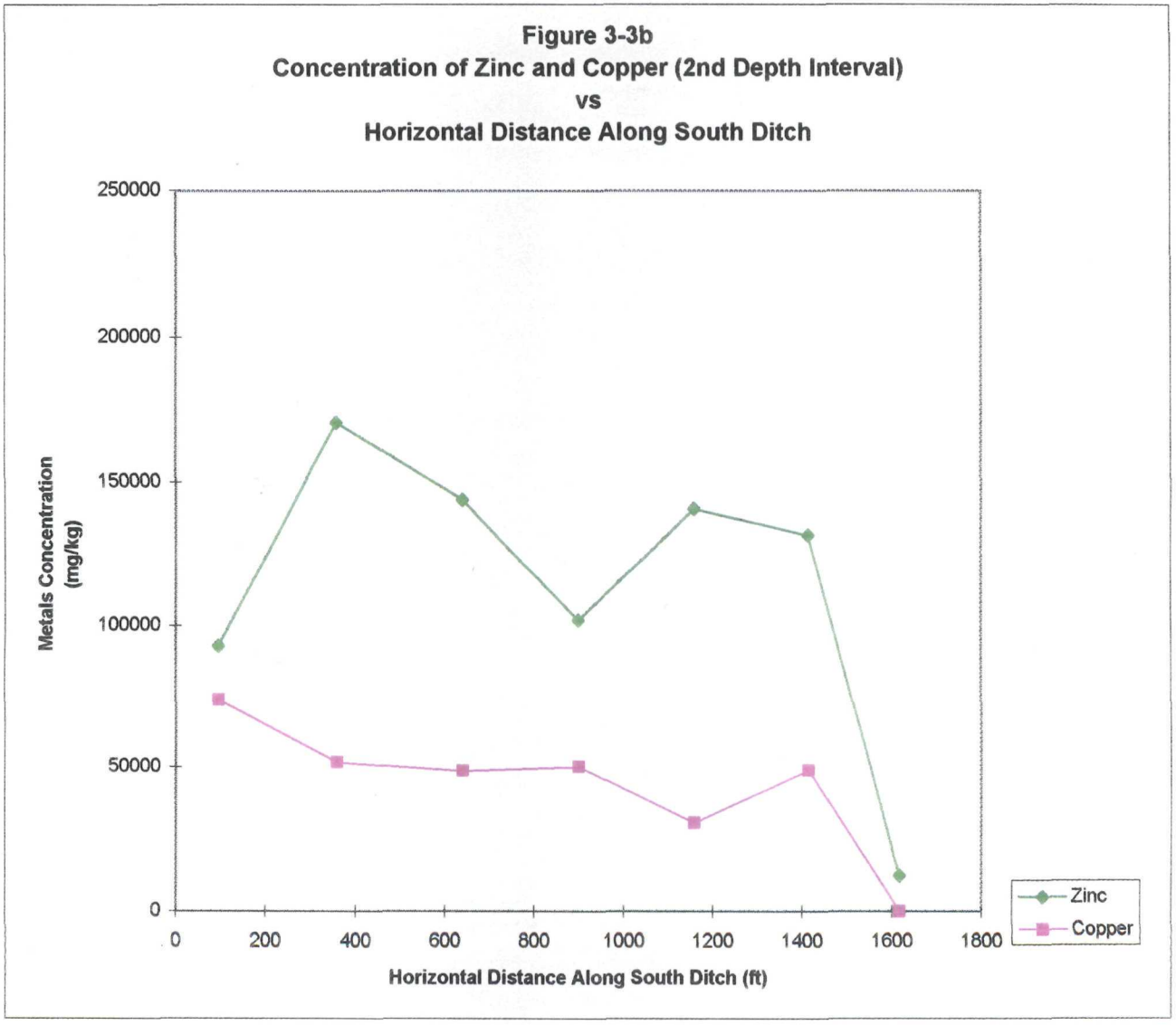

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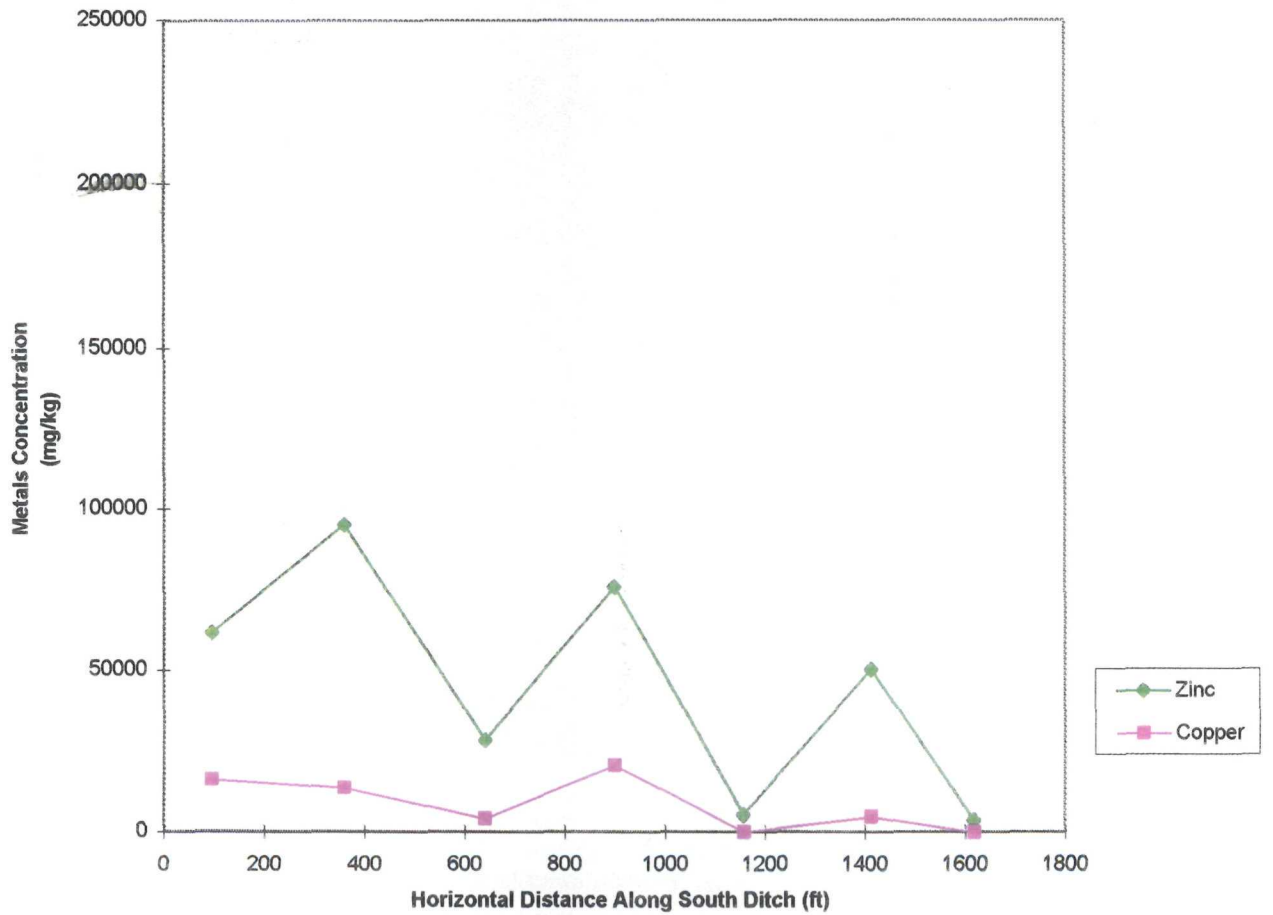
Figure 3-3c
Concentration of Zinc and Copper (3rd Depth Interval)
vs
Horizontal Distance Along South Ditch



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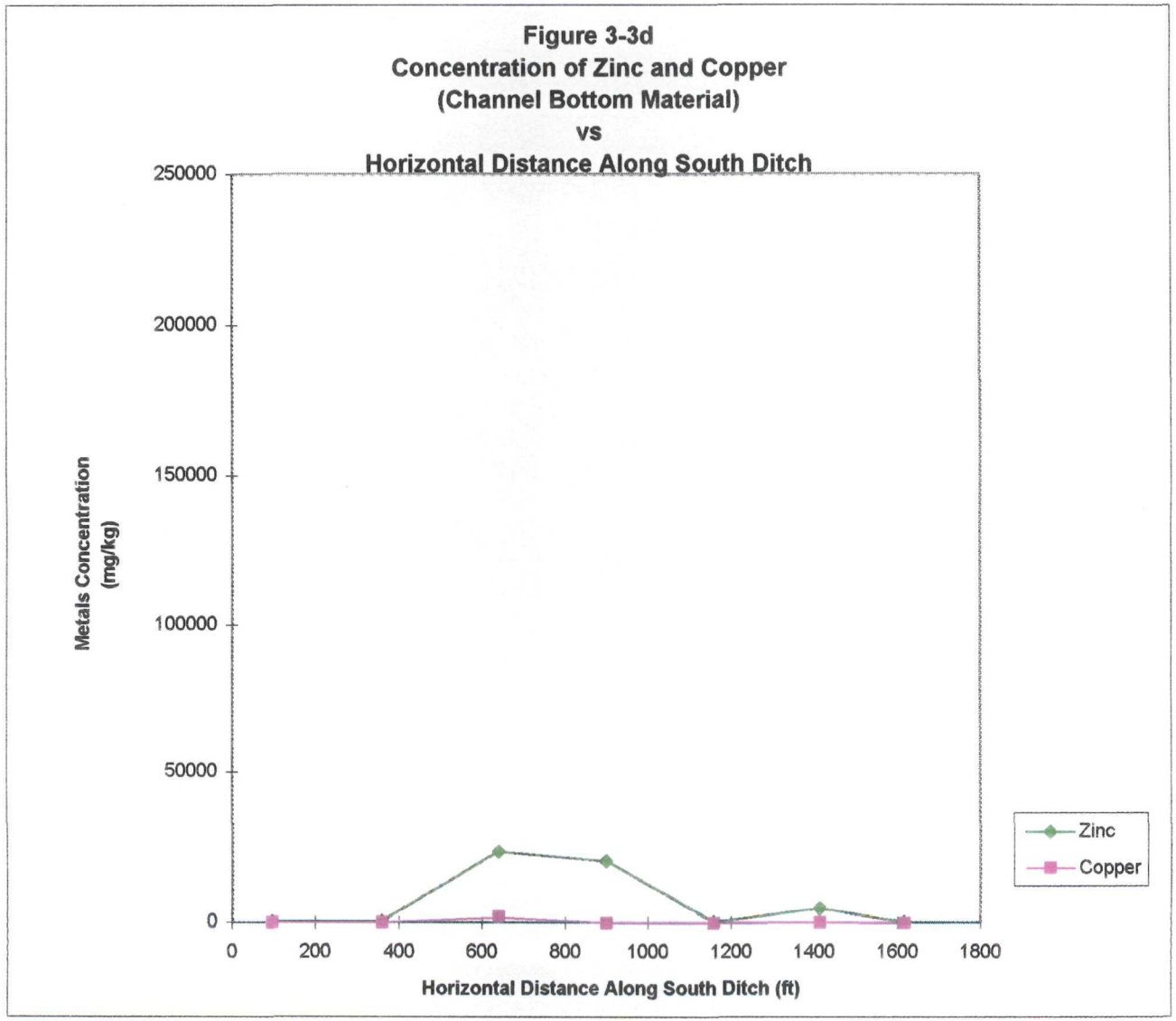
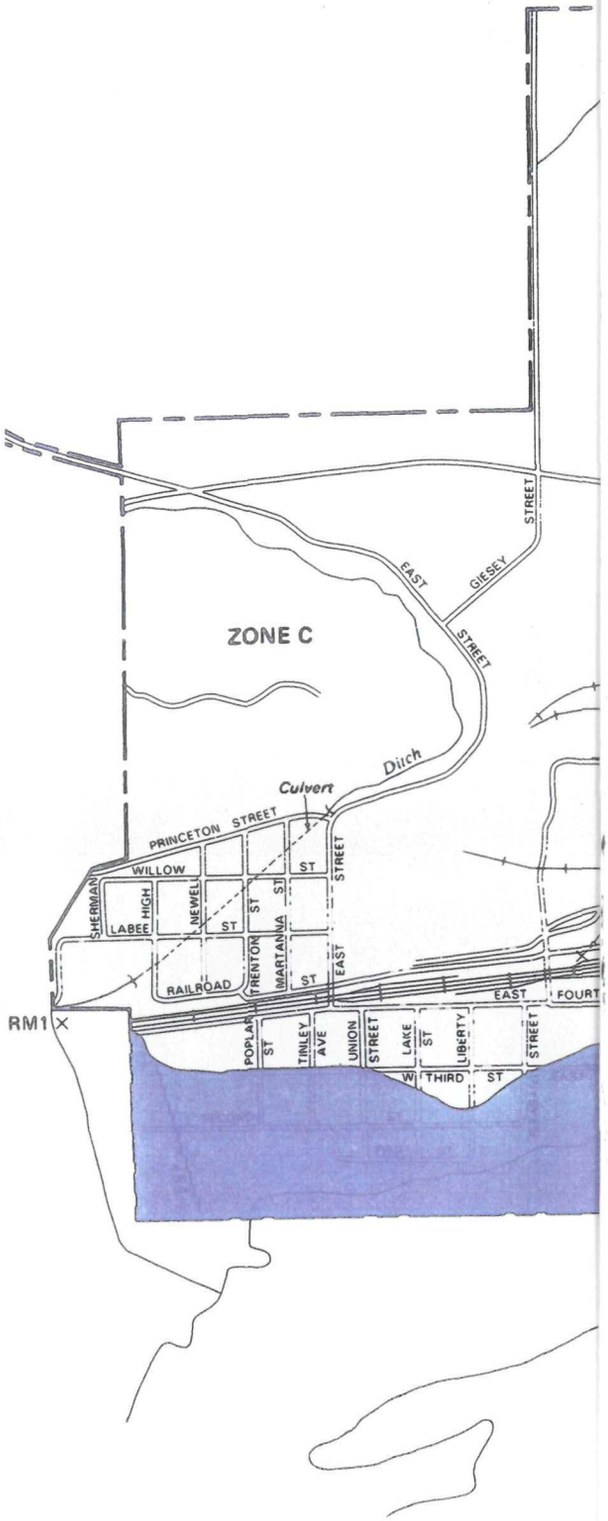


Figure 3-3d
Concentration of Zinc and Copper
(Channel Bottom Material)
vs
Horizontal Distance Along South Ditch
Metals Concentration (mg/kg)
250000
200000
150000
100000
50000
0
0
200
400
600
800
1000
1200
1400
1600
1800
Horizontal Distance Along South Ditch (ft)
Zinc
Copper



LEGEND

ZONE A13 – INDICATES AREA WITHIN 100-YEAR FLOOD PLAIN

ZONE C – AREAS OF MINIMAL FLOODING

~~464~~ – INDICATES 100-YEAR FLOOD PLAIN ELEVATION

N

800 0 800

SCALE IN FEET

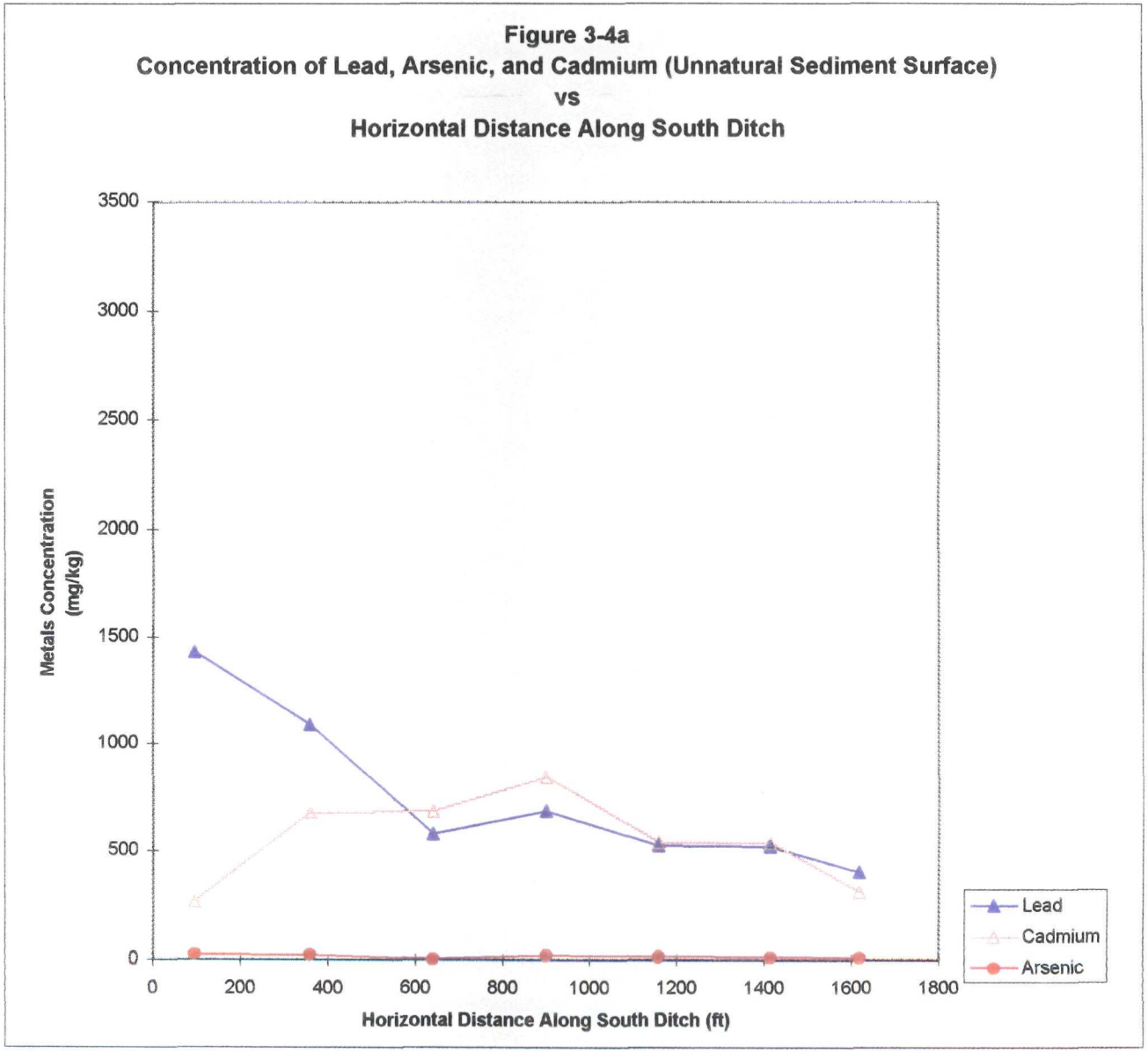
SOURCE: NATIONAL FLOOD INSURA
VILLAGE OF DEPUE, ILLI

TLE

100-YEAR FLOOD PLAIN

AWN NAP	DATE 8/7/96	JOB NO. 953-8222	
ECKED	SCALE AS SHOWN	DWG. NO.	
VIEWED	FILE NAME 8222176	FIGURE NO. 3-4	

Figure 3-4a
Concentration of Lead, Arsenic, and Cadmium (Unnatural Sediment Surface)
vs
Horizontal Distance Along South Ditch



(8222A431.XLS)

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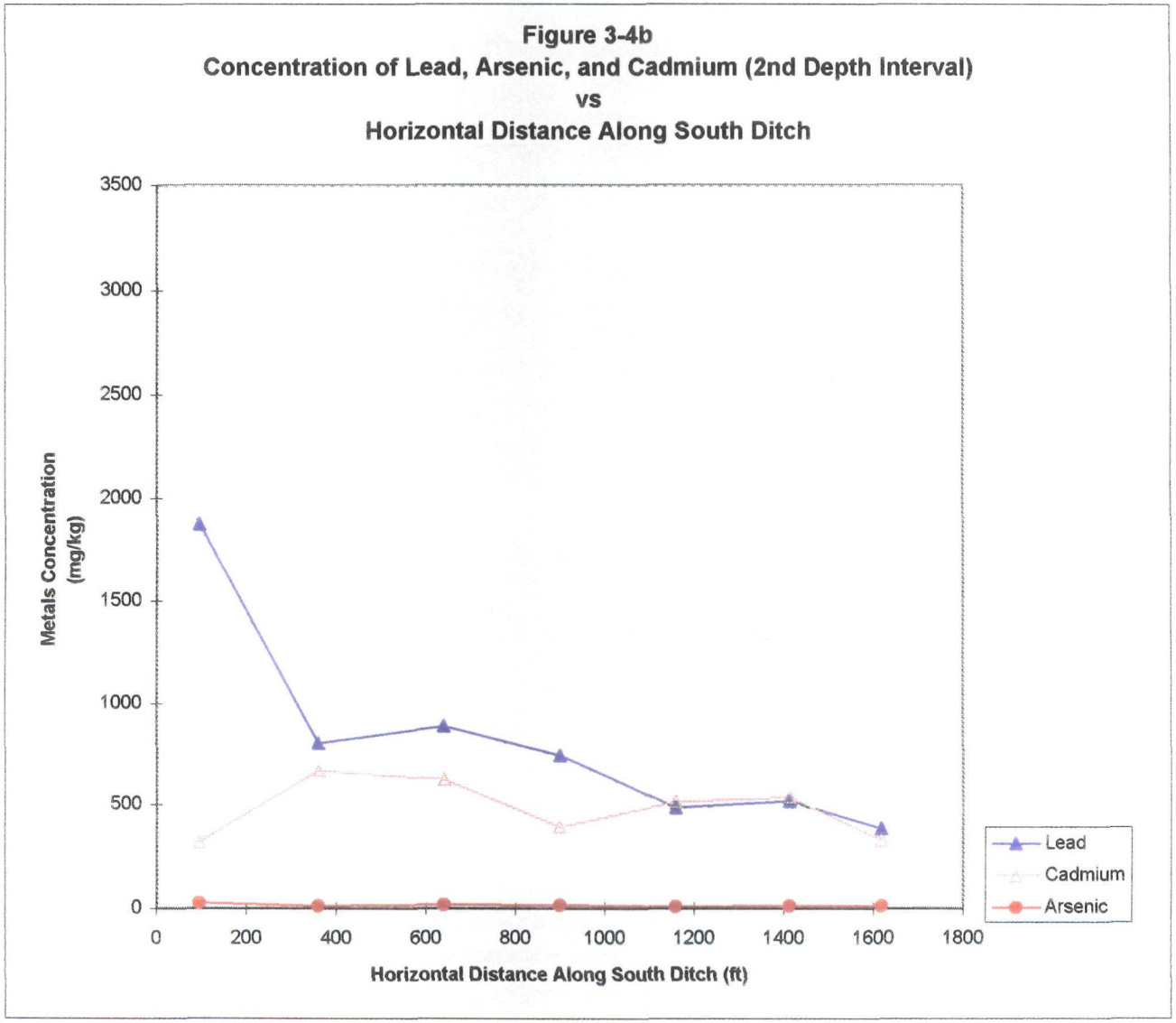
Figure 3-4b
Concentration of Lead, Arsenic, and Cadmium (2nd Depth Interval)
vs
Horizontal Distance Along South Ditch



(8222A431.XLS)

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Figure 3-4c
Concentration of Lead, Arsenic, and Cadmium (3rd Depth Interval)
vs
Horizontal Distance Along South Ditch

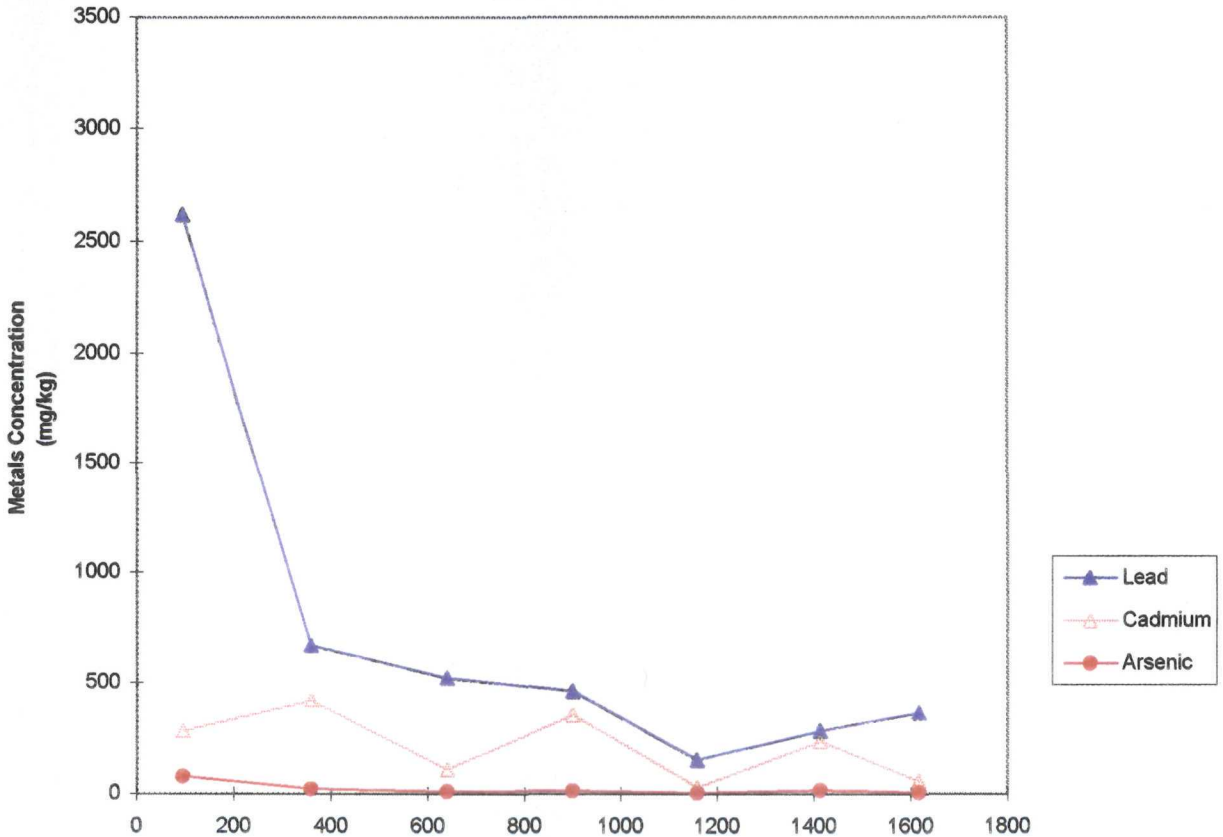

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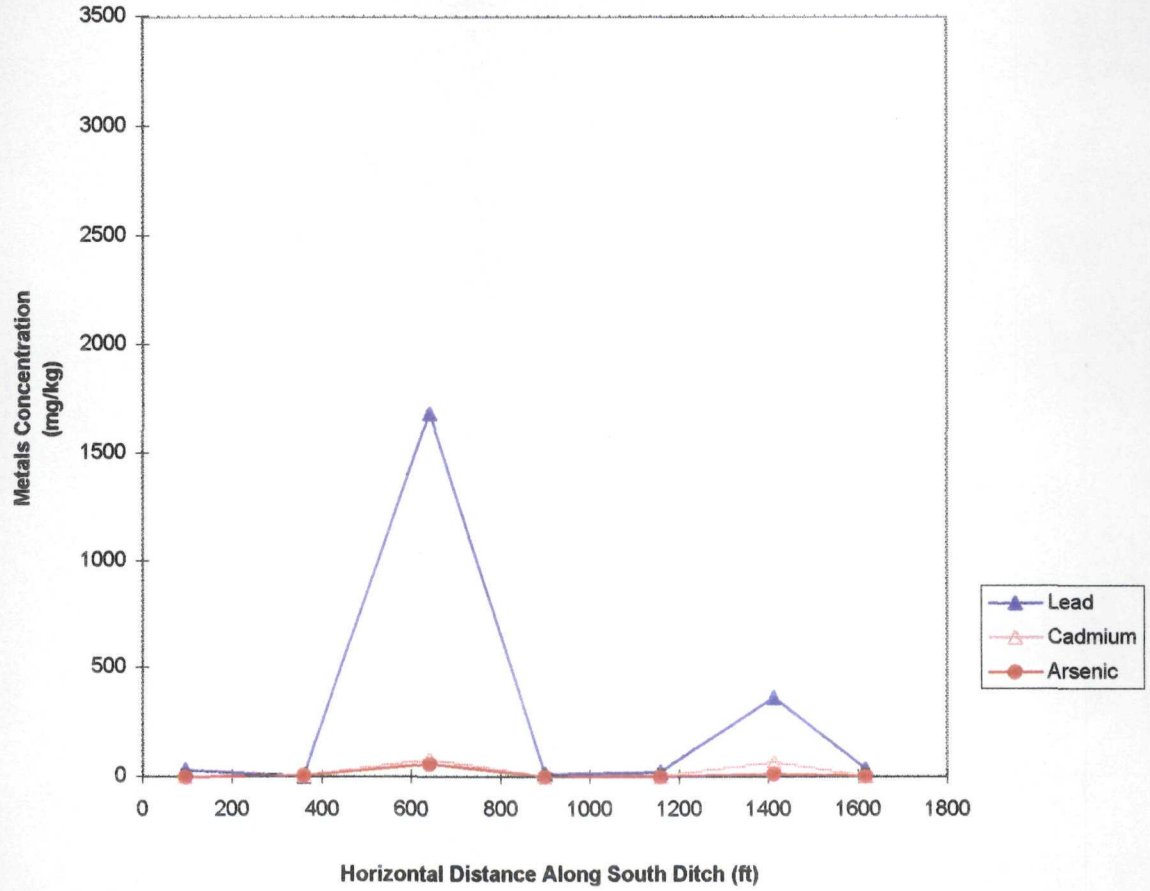
Figure 3-4d
Concentration of Lead, Arsenic, and Cadmium
(Channel Bottom Material)
vs
Horizontal Distance Along South Ditch



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